Dr. Stephen Rinehart
Director, Planetary Research Programs

PAC Meeting
November 15, 2021

ROSES20: Summary

All ROSES20 solicitations are now done. Some statistics:

- 1595 proposals were submitted across all programs
- 307 proposals were selected (will go up slightly)
- 19.2% overall selection rate
- Average time to notification was 154 days
  - Improvement over the past 2 years!
  - Two programs (PDART and LARS) exceeded 180 days; five programs were at less than 100 days.
- Very positive reviews of our DAPR experiment – more on that later

For comparison

ROSES19

- 1568
- 242
- 15.4%
- 166 days

Reminders on ROSES 21

- No-Budget experiment with DDAP
- Dual-Anonymous Peer Review for all Data Analysis Programs (DAPs)
- No Due Date (NoDD) programs (open now!)
  - https://science.nasa.gov/researchers/NoDD
- Remember rules on duplicate proposals (see C.1)
- Compliance: We are checking and strictly enforcing compliance rules. Non-compliant proposals may be returned without review or be declined on this basis *regardless of intrinsic merit score from the panel.*

PMEF in ROSES21 and ROSES22

- Replacing the ROSES21 Planetary Major Equipment & Facilities (PMEF) call with the Planetary Science Enabling Facilities (PSEF) call
  - This is only the stand-alone part of PMEF, no change to ”appended” PMEF proposals
  - PSEF is the broader Facilities program that we’ve talked about before; another talk on this topic later in the meeting.
- In ROSES22, PMEF will exist as a funding line but not as an appendix (PSEF will be there). “Appended” requests will be handled a bit differently.
  - Again, wait for Aaron’s talk.

Planetary Science Division ROSES 21 Program	Step-1 Due Date	Step-2 Due Date	Panels Held	Selections/ Proposals	Selection Dates	Days from Step-2 to Select
Planetary Protection Research	**04/12/2021**	**05/13/2021**	Yes	5/10 (50%)	10/15/2021	155
Exoplanets Research Program	**04/02/2021**	**05/27/2021**	Yes	22/183 (12%)	10/6/2021	132
Development and Advancement of Lunar Instrumentation	**04/16/2021**	**06/16/2021**	Yes	xx/44	TBD	
Yearly Opportunities for Research in Planetary Defense	**04/22/2021**	**06/17/2021**	Yes	12/23 (52%)	10/19/2021	124
Cassini Data Analysis Program[1]	**05/07/2021**	**07/09/2021**	Yes	15/38 (39%)	10/8/2021	92
Hot Operating Temperature Technology	**06/01/2021**	**08/03/2021**	Yes	7/38 (18%)	11/15/2021	104
Juno Participating Scientist Program	**06/14/2021**	**08/13/2021**	Yes	10/27 (37%)	11/12/2021	91
VIPER Mission Co-Investigator Program	**07/02/2021**	**08/31/2021**	No	xx/50		
Planetary Science and Technology Through Analog Research	**07/23/2021**	**10/07/2021**	No	xx/49		
New Frontiers Data Analysis Program[1]	**09/03/2021**	**11/04/2021**	No	xx/21		
Mars Science Laboratory Participating Scientist Program[1]	**09/15/2021**	**11/05/2021**	No	xx/50		
Mars Data Analysis[1]	**09/24/2021**	11/18/2021	No			
Discovery Data Analysis[1]	**09/28/2021**	11/23/2021	No			
Planetary Science Early Career Award	N/A	12/08/2021	No			
Planetary Major Equipment and Facilities (stand alone proposals)	12/03/2021	02/03/2022	No			
Lunar Data Analysis[1]	12/01/2021	02/24/2022	No			
Martian Moons eXploration Participating Scientist Program	TBD	TBD	No			
Future Investigators in NASA Earth and Space Science and Technology	N/A	TBD	No			

1: DAPR Program

Highlighted in Yellow = Cross-Divisional
Not solicited this year: MatISSE, ICAR, Habitable Worlds

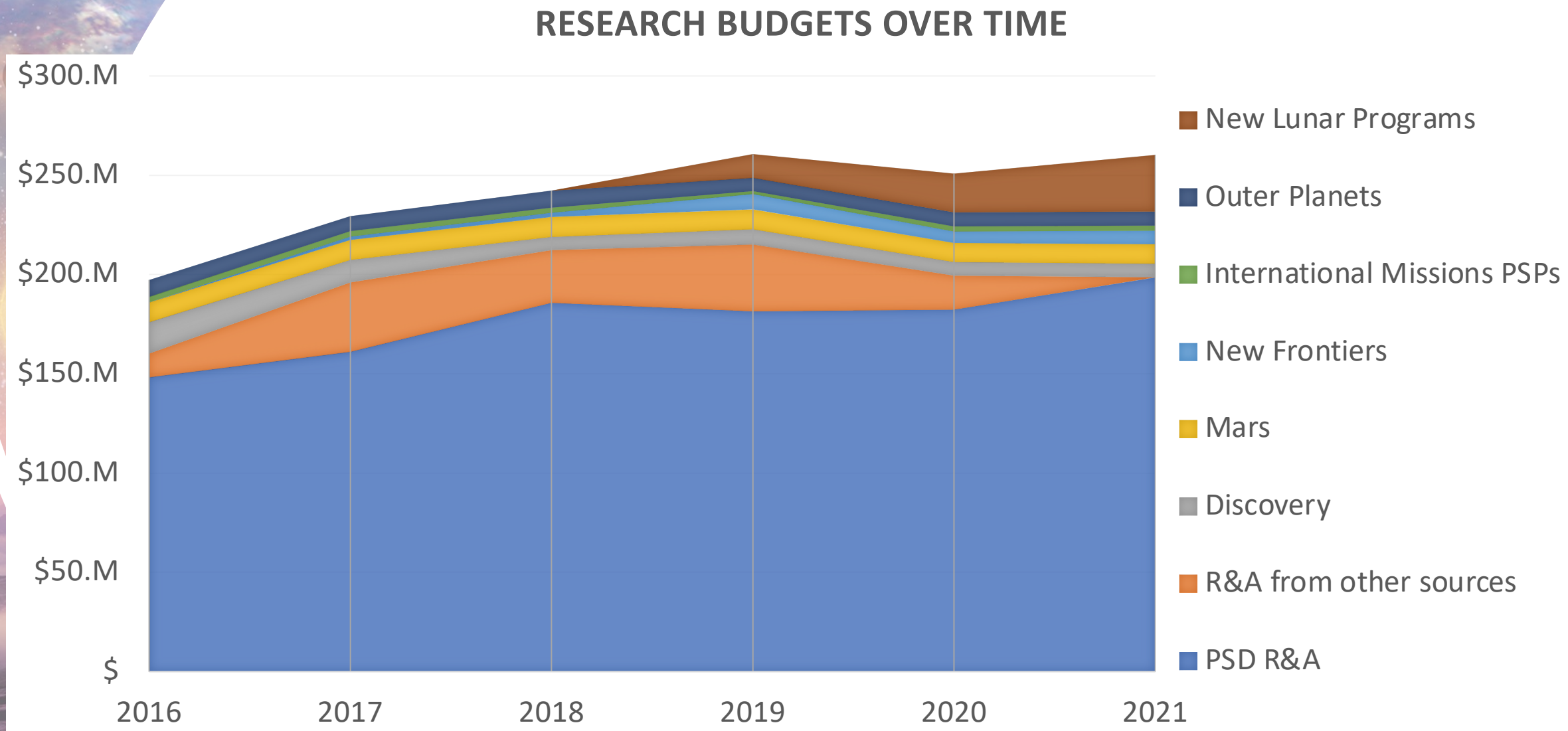
NoDD programs

We are not yet reporting on individual programs, as we feel that would be premature:

- Several programs just passed their “anniversary date”. One program (SSW) has an anniversary date in January.

- 45% of all proposals received under NoDD have been reviewed as of 11/4/21 (more reviews will be completed by the time you see this).
- Selection rates so far are comparable to those from ROSES20, but we anticipate that they will go up as more reviews are completed.
- Average notification time is currently <120 days (across all programs) and we expect it to go down at least a little. Only one proposal has exceeded the targeted maximum time to notification (235 days).

FY21 Budget

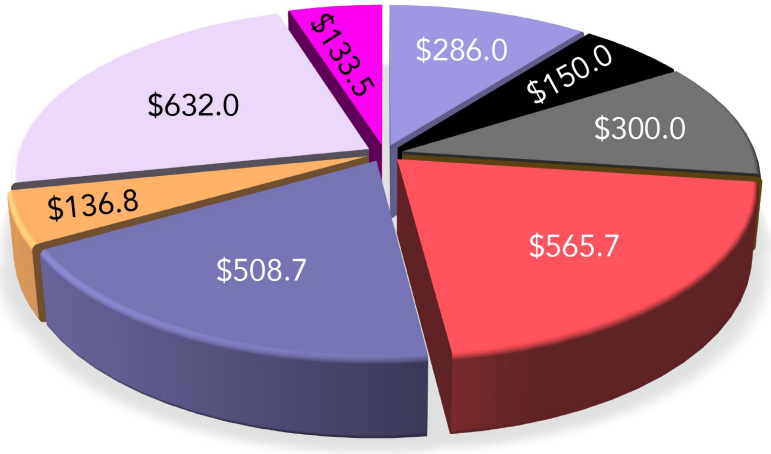

RESEARCH BUDGETS OVER TIME
$300.M
$250.M
$200.M
$150.M
$100.M
$50.M
$
2016
2017
2018
2019
2020
2021
New Lunar Programs
Outer Planets
International Missions PSPs
New Frontiers
Mars
Discovery
R&A from other sources
PSD R&A

Repeat of slide from last PAC

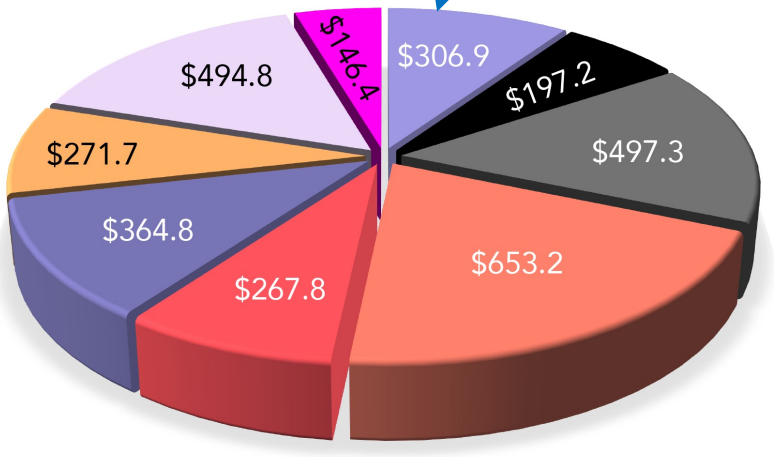
FY22 Budget

R&A lives here, along with AMMOS, PDS, etc.

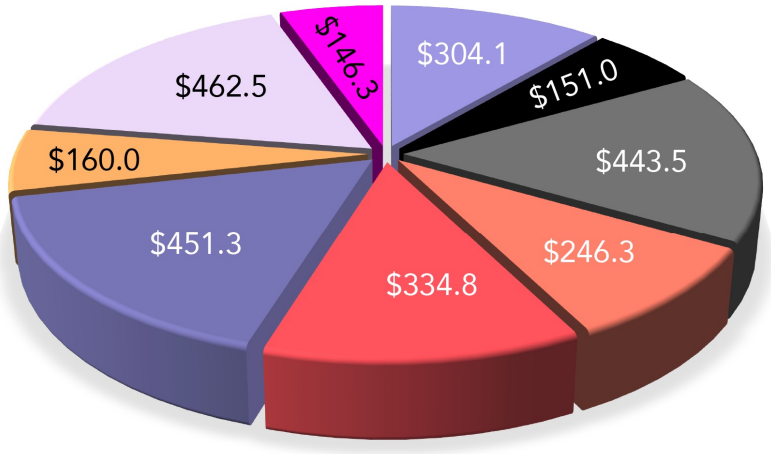
FY20 Actual (Total: $2,712.6M)



FY22 Request (Total: $3,200.0M)



FY21 Operating Plan (Total: $2,699.8M)



The FY22 President's Budget Request includes $11M additional funding for R&A!

This funding will be incredibly valuable, allowing us to:

- Establish a Facilities program
- Significantly reduce or eliminate all of the out-year "mortgages" for R&A.

ROSES22: Some changes

- PMEF turning into PSEF (as already mentioned)
- We expect to have several new calls
  - Apollo Next Generation Sample Analysis 2 (ANGSA-2)
  - Desert Research and Technology Studies (D-RATS)
  - Artemis Geology Team
  - OSIRIS-REx Sample Analysis PSP
- PDART: under ROSES22, PDART will not accept any proposals for development or validation of tools
  - Reason: The Planetary Data Ecosystem review highlighted some weaknesses in how tools are developed *and supported*. We need to change how this is done moving forward.

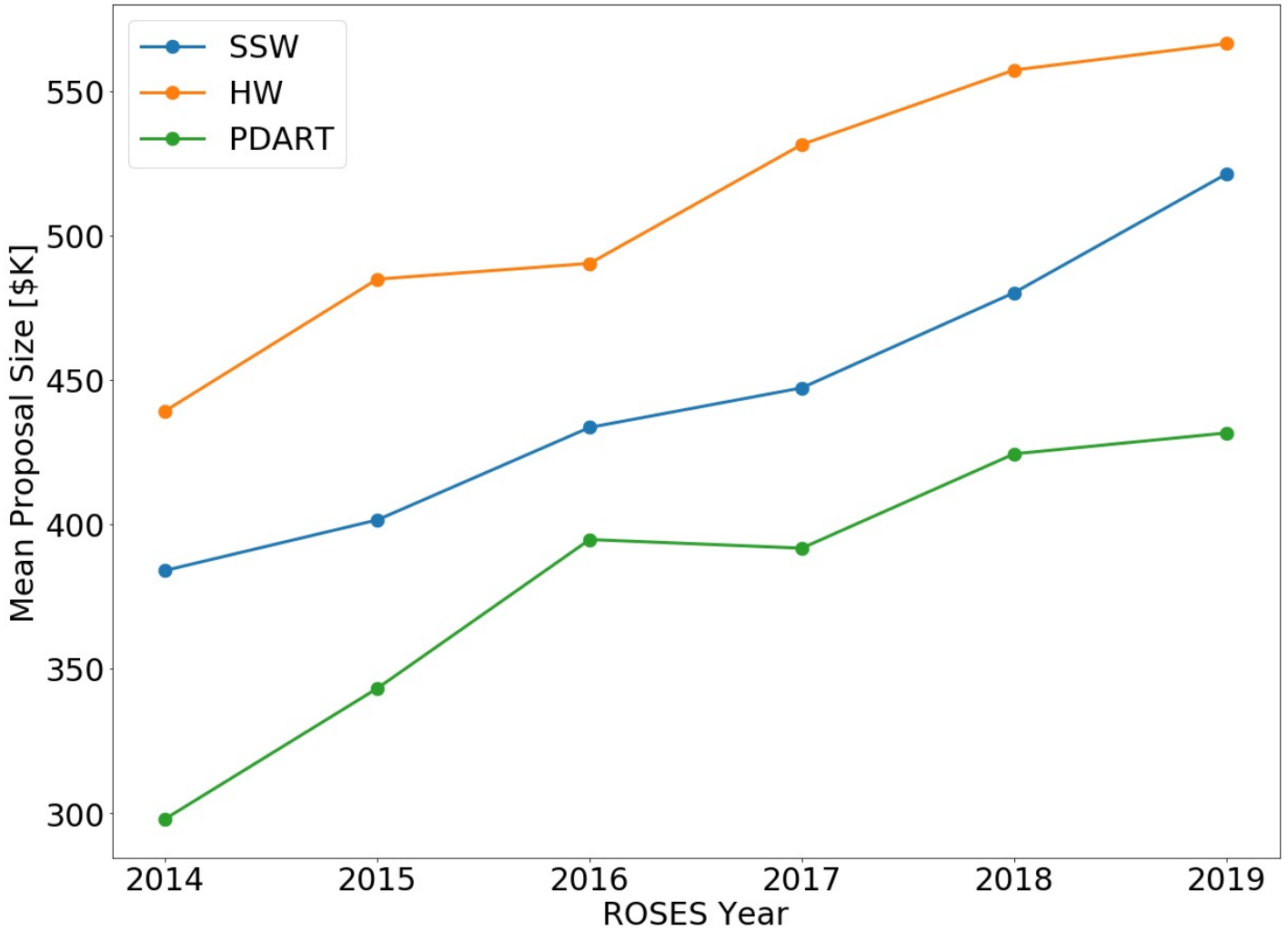
Rising Proposal Budgets: Revisited

This is data you've seen before: Submitted proposal budgets are increasing at rates well-above inflation.

Why?

Possibilities:

1. Team size (FTEs) is growing
2. Some particular element(s) are growing very fast

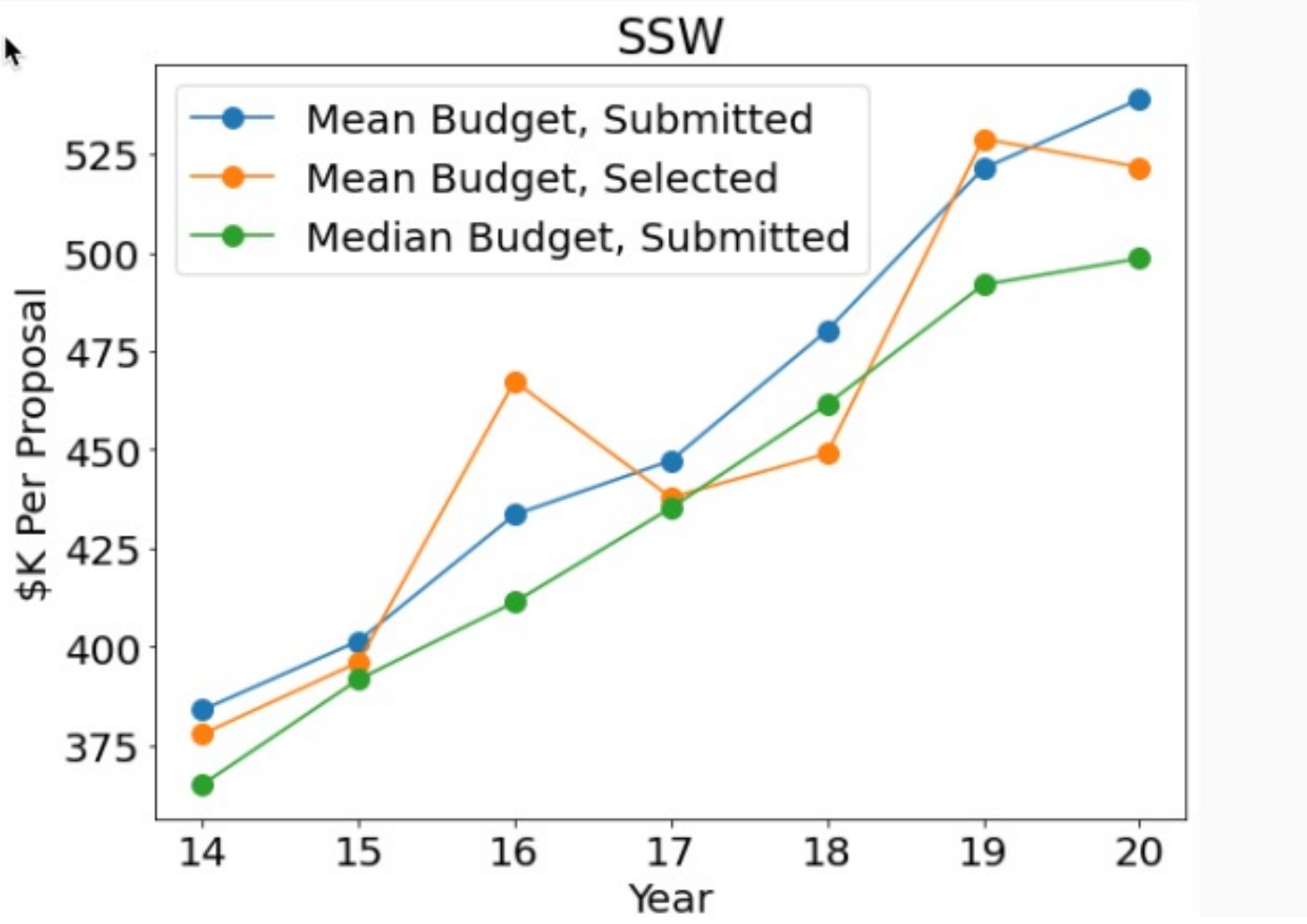


Rising Proposal Budgets: Example

Data from SSW – 40% cost growth in 6 years (SSW is not unique in this regard!)

Takeaways:

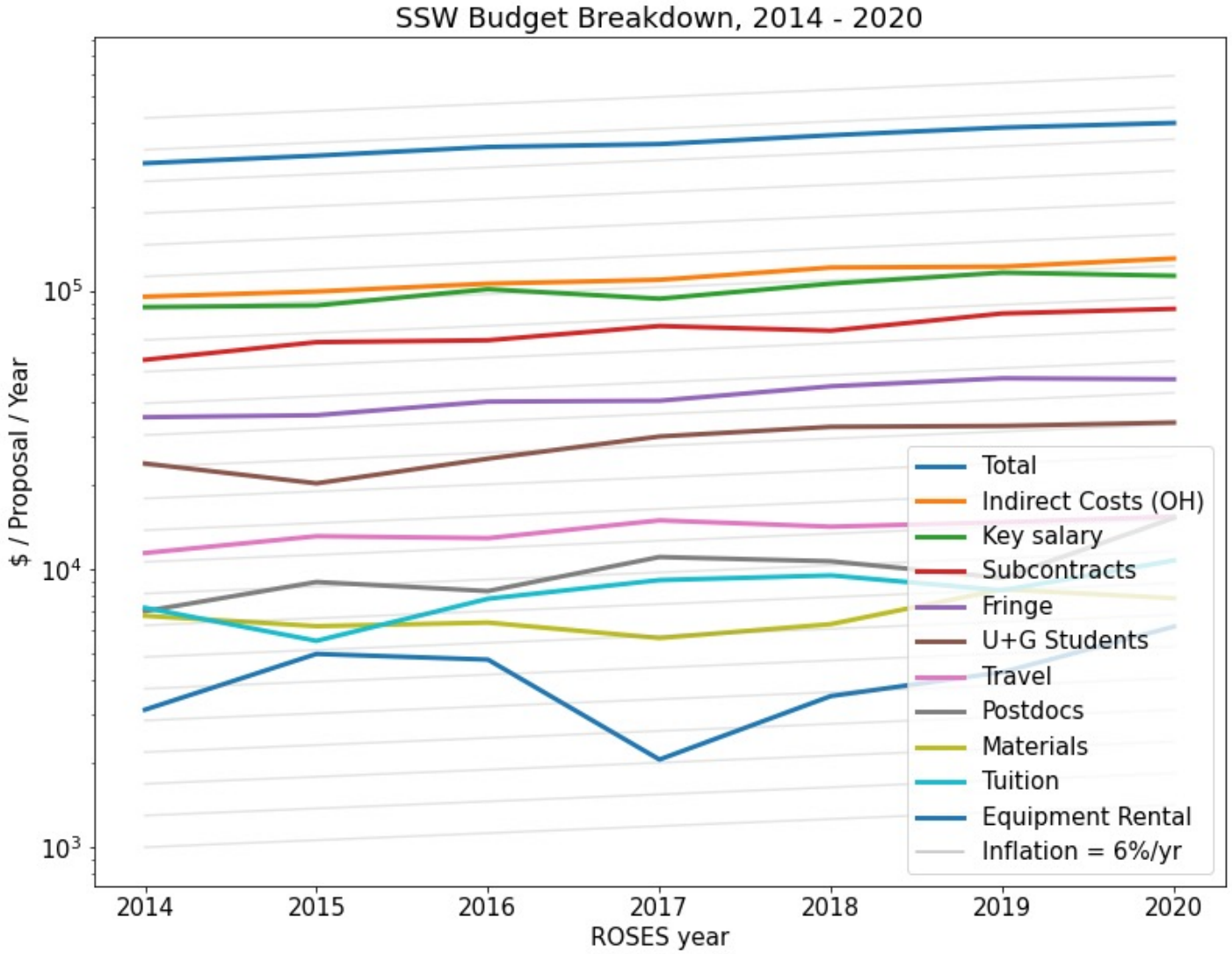
- Selections are not biased for or against expensive proposals
- Median is lower than mean – we have a ”tail” on the high-cost end.
- The trend is effectively linear



Rising Proposal Budgets: Breakdown

Breakdown budget into subcomponents: *this is taken from NSPIRES cover page information, and does have uncertainties*

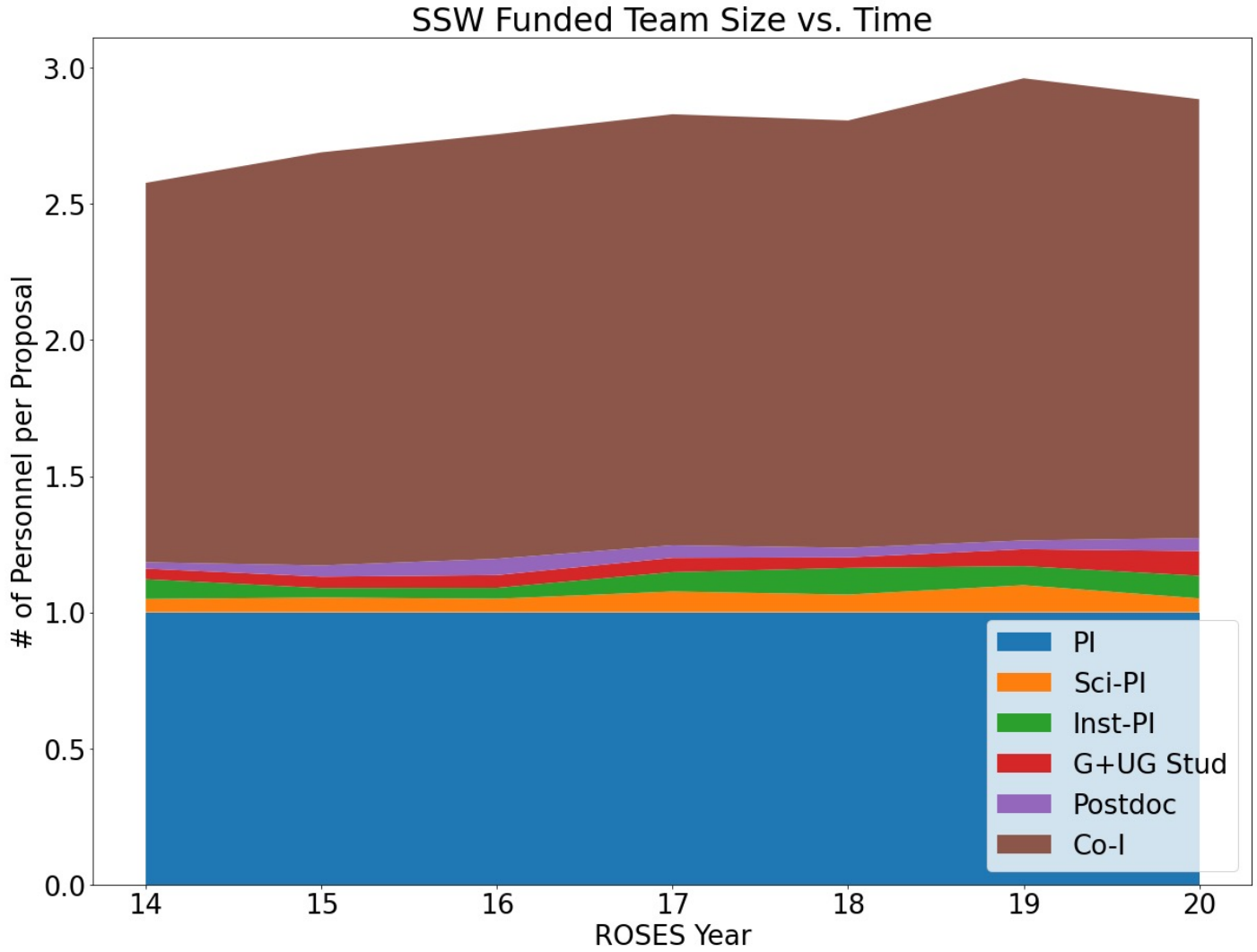
- Salary and Indirects are the highest individual cost components
- All components (save one) are growing at around 6%/year
- Subawards are growing a bit faster.
- **No obvious culprit!**



Rising Proposal Budgets: Team Size

Are teams getting bigger?

- Yes, but not nearly at the same rate. Team size grows at ~2% / year (~10% over the last 6 years)
- Are teams asking for more FTEs?
  - We can't tell – while information is in the Table of Work Effort for each proposal (as required in ROSES), those tables aren't easily parsed.



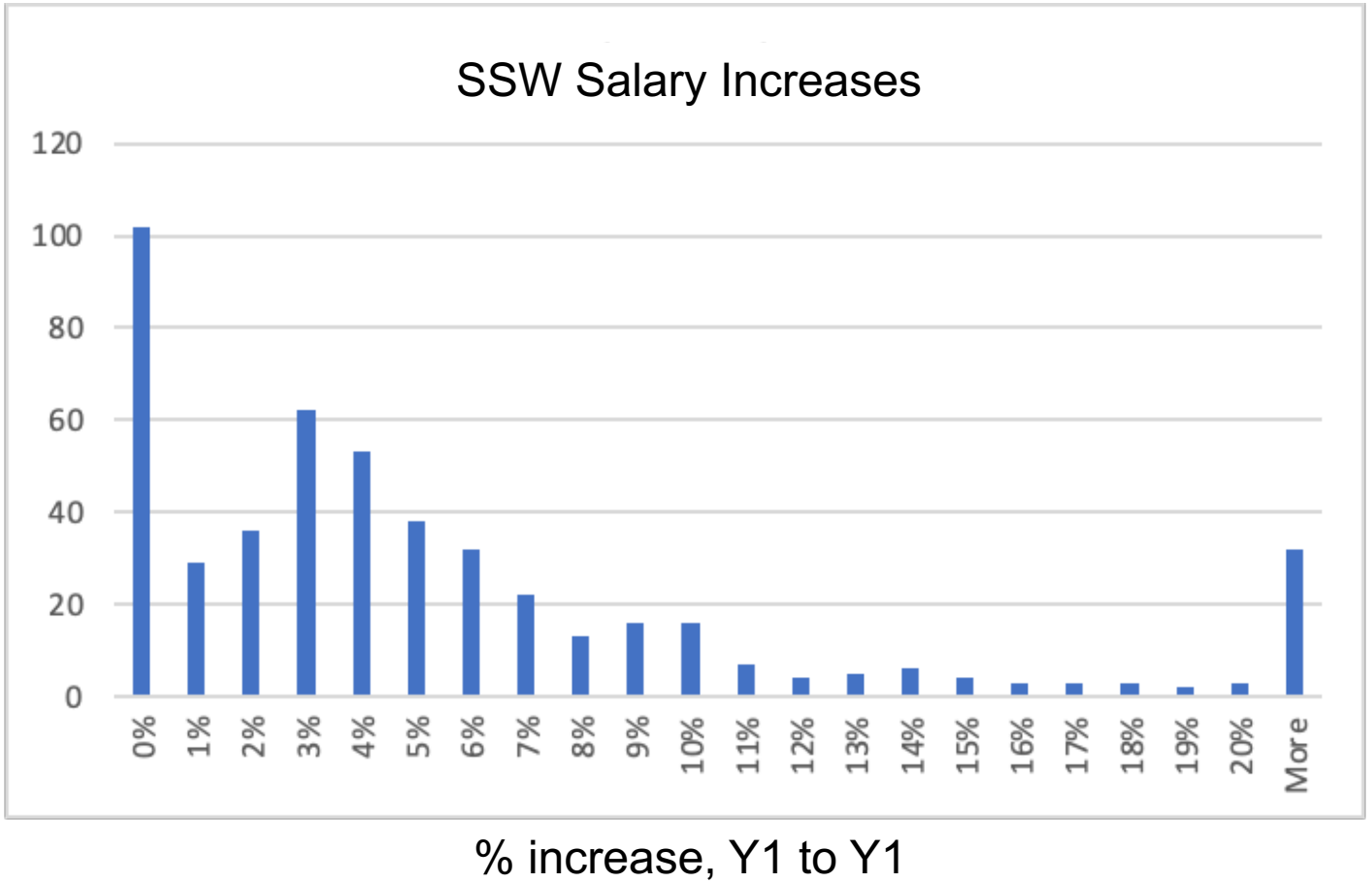
Rising Proposal Budgets

Salaries themselves appear to be growing at a rate in excess of inflation.

Mean salary increases are 3.6%/year.

Combine this with 2%/year growth in team size, and it's just about the 6% we see.

Is that it?



Excessive Fringe/Inflation

It has been noted that some proposals have excessive fringe rates and/or relatively large inflation factors built into a budget:

1) NSSC notices these things and flags them.
2) These can lead to significant delays in sending out new awards
3) In these instances, budgets will also be reduced per NSSC findings

What is “excessive”?

- Inflation rates >3%
- Fringe rates

Allowable costs for data archiving

Can a proposal include effort for data archiving?

- Yes
- Of course, any effort included in a proposal will be part of the peer review, so should have an appropriate justification.

Grant funding for Community Service

This came up at the last PAC, and after discussion with grants folks, we have a better answer:

- May proposals include time for community service?
  - Short answer: No
  - Longer answer: Anything charged to the grant has to be “allocable” – i.e., the costs incurred further the funded activity.
    - Review panels were specifically called out as an unallocable cost
  - Service **can** be covered through overheads on grants, but that is a matter of written institutional policy

High-Risk / High-Impact: Update

After discussion within SMD, the special high-risk / high-impact “blue ribbon” panel will not be done again (at least for now).

- Data so far shows that HR/HI proposals are selected at the same or higher rates than proposals in general.
- The additional effort required from both Principal Investigators and Program Officers was found to be high.

PSD (and SMD) continues to encourage submission of HR/HI proposals!

SMD has established a Research Catalyst Fund (next slide) that will provide some additional support for proposals of broad interest to SMD.

SMD Research Catalyst Fund

- RCF is a small SMD-level funding line designed to act as a focal point and catalyst for programmatic activities that cut across the directorate's science disciplines.
- RCF co-funds disciplinary research awards based on four priorities. It is not a separate solicitation.

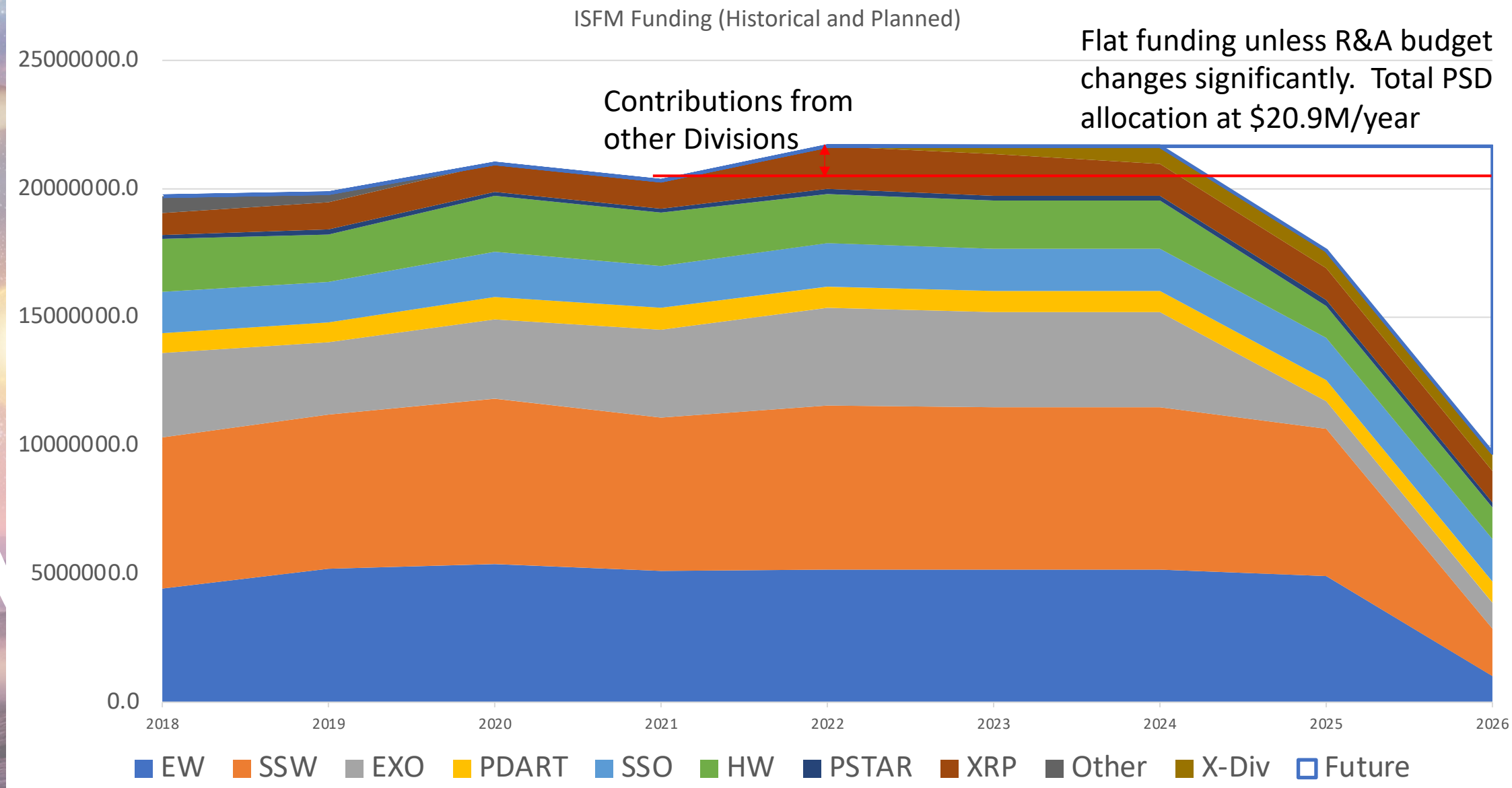
ISFM Update: ISFMs renewed

Center	ISFM	Lead	FY22	Duration	Last Review	Reproposed	Next Review	Other Divisions
ARC	Mars Climate Modeling Center (MCMC)	Kahre	1,280,000	10/21-9/24	Jun-20	Mar-21	~Mar-23	
ARC	Habitable Environments and Biosignatures / Center for Life Detection (HEB/CLD)	Hoehler & Parenteau	1,615,000	10/21-9/24	Jun-20	Mar-21	~Mar-23	BPSD
ARC/GSFC	Evolutionary Processes that Drove the Emergence and Early Distribution of Life (EPDEL)	Ditzler & Pohorille	857,000	10/21-9/24	Jun-20	Mar-21	~Mar-23	BPSD
ARC	NASA Center for Optical Constants (NCOC)	Sciamma-O'Brien	297,200	10/21-9/24	Jun-20	Mar-21	~Mar-23	
ARC	Astrobiologically Important Organics during Early Planetary System Formation and Evolution	Sandford	300,000	10/21-9/24	Jun-20	Mar-21	~Mar-23	
GSFC	Planetary Geodesy	Mazarico	545,000	10/21-9/26	Jun-20	Mar-21	~Oct-24	
GSFC	Fundamental Laboratory Research (FLaRe)	Elsila & Stern	4,100,000	10/21-9/26	Jun-20	Mar-21	~Oct-24	
GSFC/ARC	The Goddard Instrument Field Team (GIFT)	Young & McAdam	778,989	10/21-9/26	Jun-20	Mar-21	~Oct-24	
GSFC	Sellers Exoplanet Environments Collaboration (SEEC)	Mandell & Kopparapu	2,378,000	10/21-9/26	Jun-20	Mar-21	~Oct-24	APD/HSD
GSFC	Exosphere-Ionosphere-Magnetosphere Modeling (EIMM)	Sarantos & Tucker	1,220,000	10/21-9/26	Jun-20	Mar-21	~Oct-24	HSD
GSFC	(R3D) Resolving Orbital and Climate Keys of Earth and Extraterrestrial Environments with Dynamics	Way & Kiang	199,423	10/21-9/26	Jun-20	Mar-21	~Oct-24	
JSC	Coordinated Analysis (CA)	Keller	1,950,000	10/21-9/25	Jun-20	Mar-21	~Oct-23	
JSC	Geo-Cosmochemistry (GC)	Simon	2,199,938	10/21-9/25	Jun-20	Mar-21	~Oct-23	
JSC	Planetary Process Simulation (PPS)	Righter	1,320,657	10/21-9/25	Jun-20	Mar-21	~Oct-23	
JSC	Organic Geochemistry (OG)	Burton	500,862	10/21-9/25	Jun-20	Mar-21	~Oct-23	
JSC	Mission Enabling (ME)	Rampe	1,092,143	10/21-9/25	Jun-20	Mar-21	~Oct-23	
MSFC	Marshall Interdisciplinary Planetary Science	Zanetti	630,000	10/21-9/25		Mar-21	~Oct-23	

Total Budget from PSD: $20.9M

Increase in PSD budget comes from moving directed work from SERA to ISFM and by moving a cross-divisional contribution into this portfolio.

ISFM Update: Budgets over time



ISFM Update: Quad Charts & Communication

We are not presenting them today, but we have quad charts for all of the ISFMs to give status updates. Those charts have been sent to the PAC and will be posted with this presentation.

Question for the PAC: (Maybe you can’t answer this yet)
Is this a good way to keep you informed of ISFM Status?

GPRAMA / Science Nuggets

It was observed this year while preparing for GPRAMA that the demographic statistics of the science highlights (nuggets) tends to skew towards: more senior; male; Caucasian.

We want the highlights to reflect the diversity of our community, and we're thinking about how we can improve and communicate our process to get better representation in submissions.

This will be a topic next time.

Feedback to PSD and the role of the AGs

Recently, we made some small changes to how NASA takes feedback from the AGs. To that end, a few points:

- NASA can only take Advice from a single body (the PAC), and that body operates under FACA rules. There are also laws limiting how many FACA bodies can exist.

- The AGs cannot provide advice or findings that require an official response. But,
  - The POC for each AG can take any “comments” from them and bring them back to PSD for discussion and to get answers
  - The AG can bring comments to the PAC – this is important when a particular topic may need an official response – but the PAC ultimately is responsible for determining how it will treat those comments.

The Future of Data Analysis Programs

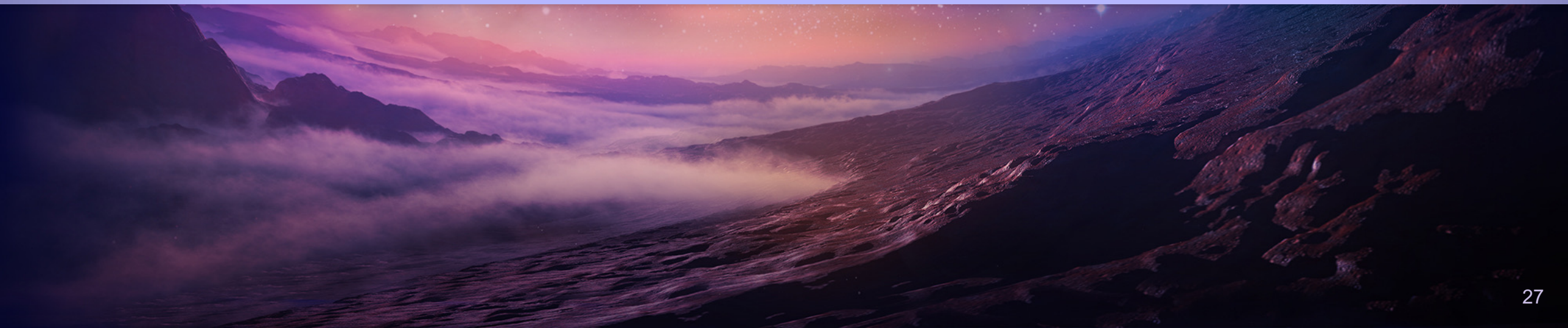
Disclaimer: There is no intent to make any major changes to the DAPs any time soon. These are topics that have been raised several times on which we felt that the PAC might have some useful advice.

Over time, many DAPs acquire ever-more eligible missions: what is the right time to "retire" a mission from DAP eligibility?

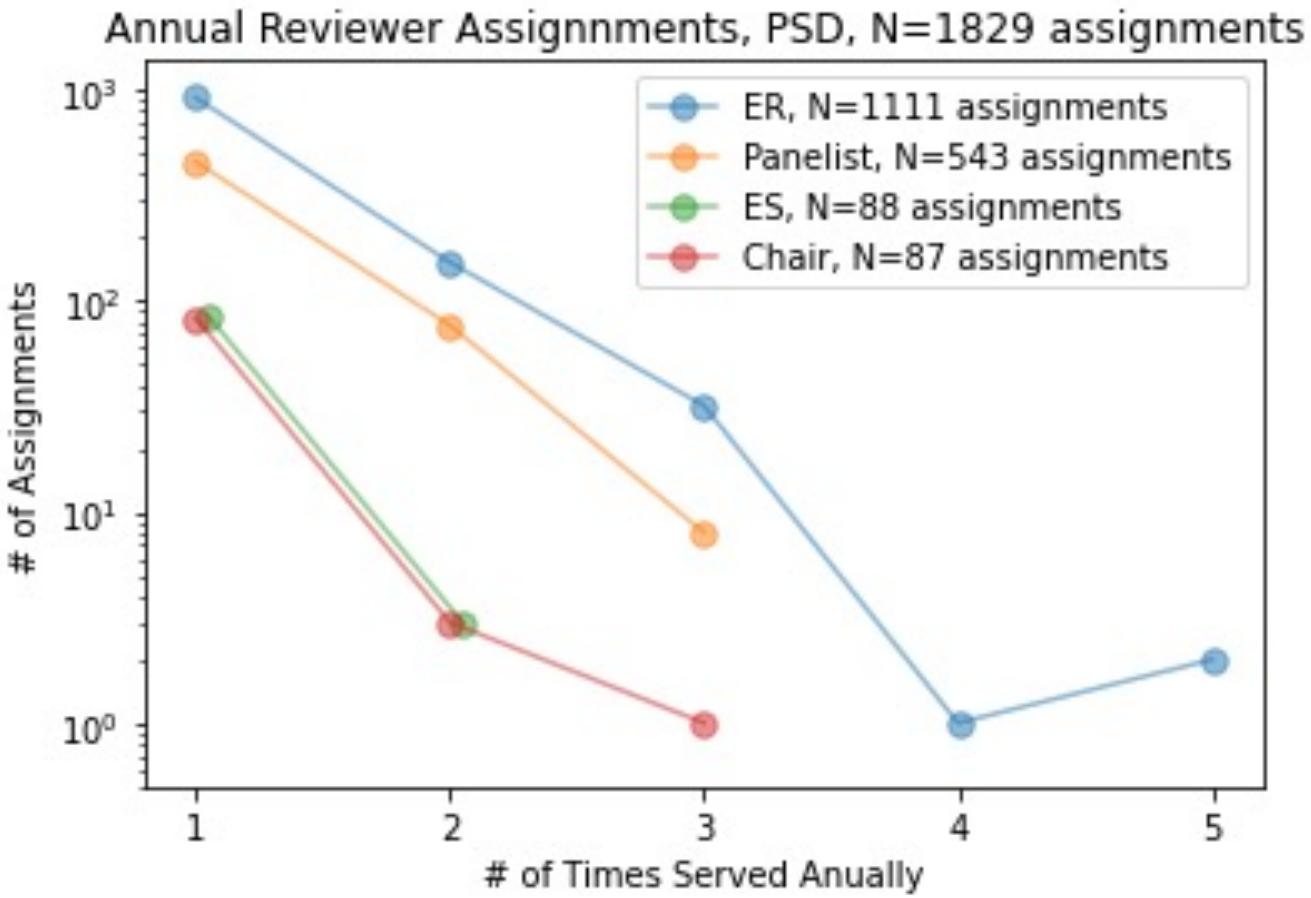
- N years after end of mission?
- When proposal pressure drops below some threshold?

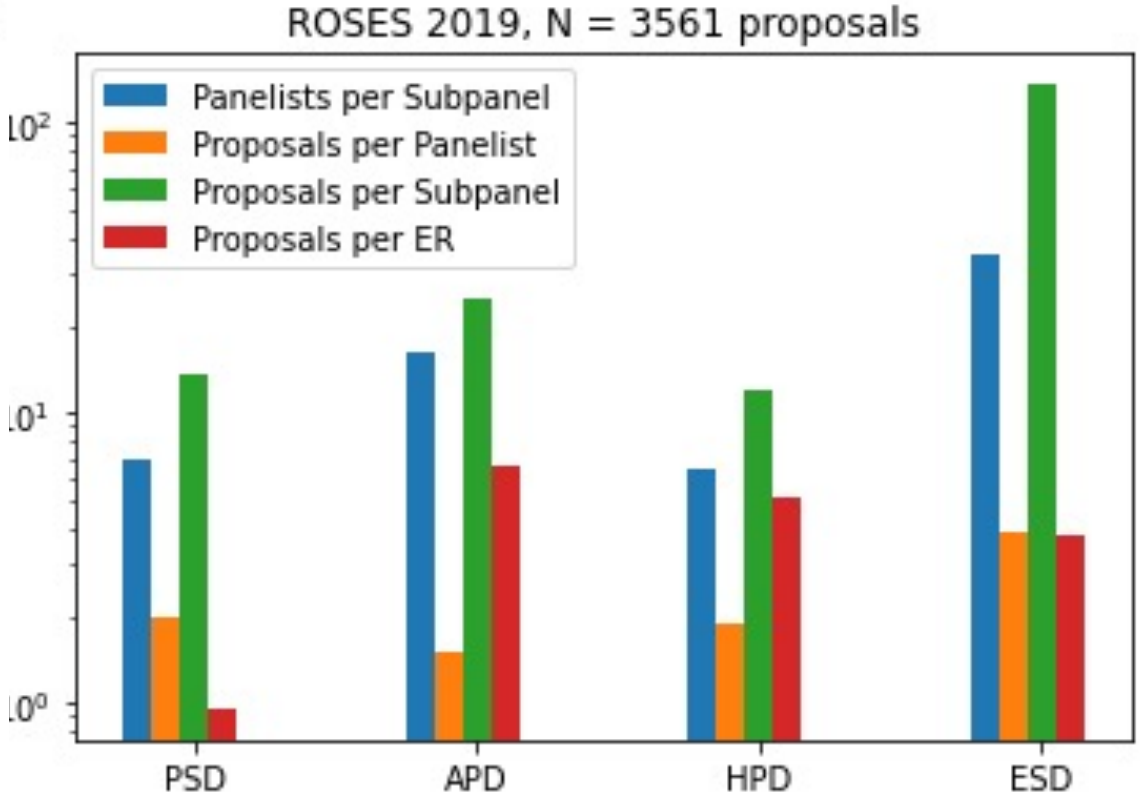
Would having a single "Planetary DAP" make sense (much like the successful Astrophysics DAP in APD)?

Backup Slides



Reviewers: A little bit of data



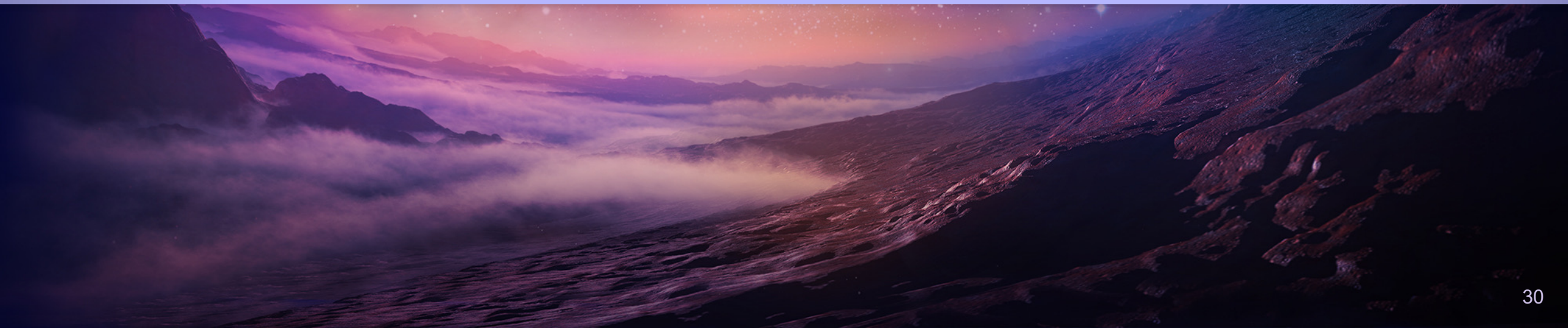


Stephen Rinehart, Ph.D.

PSD ISFM End of Year Review, Quad Charts

2021

ARC



Mars Climate Modeling Center (MCMC)

NASA SILICON VALLEY
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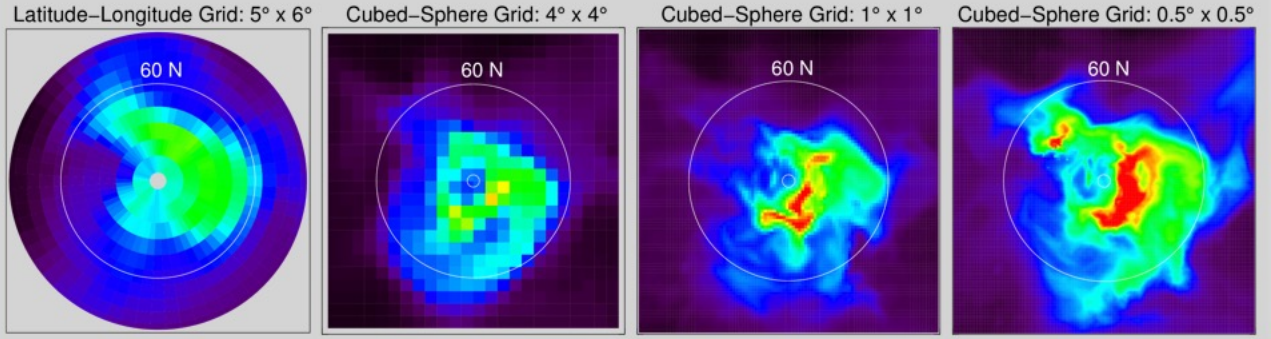
OVERARCHING PROJECT GOAL: To develop, maintain, and make available to the community, state-of-the-art Mars Global Climate Models (MGCMs).

MCMC CORE FUNCTIONS:

- Conduct cutting edge scientific research on the atmosphere and climate of Mars
- Develop and maintain state-of-the art models
- Provide access to models and output
- Support NASA missions and the Mars Exploration Program (MEP)
- Engage the community and educate next-generation climate scientists

SCIENCE & DEVELOPMENT NUGGET: MARTIAN WATER CYCLE



- FIGURE: Summertime water vapor abundances over the North Polar Residual Cap (NPRC) predicted by the Legacy MGCM (left panel) and the Cubed-Sphere MGCM (right panels).
- MAIN RESULT: High-resolution simulations capture small-scale circulations that contribute to water sublimation and the transport of water out of the polar region during summer.
- ***This project demonstrates that science and model development go hand-in-hand.***

FY 21 ACCOMPLISHMENTS AND HIGHLIGHTS:

SCIENCE:
- 14 papers submitted, in revision, in press, or published on Mars' current and past climate
- Presented 12 lead- or co-authored presentations at conferences or workshops.

MODEL DEVELOPMENT:
- New GCM based on NOAA/GFDL cubed-sphere finite volume dynamical core is under development. Basic current Mars physics are included; moving top higher is progressing.

MODEL & OUTPUT ACCESS:
- Released Legacy MGCM on NASA GitHub: https://github.com/nasa/legacy-mars-global-climate-model

MISSION SUPPORT:
- Making GCMs, GCM output, and analysis tools publicly available support the interpretation of observations (e.g., MAVEN/IUVS) and mission design studies (e.g., Aeolus).

COMMUNITY ENGAGEMENT AND EDUCATION:
- Convened session on Mars Climate Modeling at Fall AGU (December 2020).
- Held first full meeting with the Independent Working Group (January 2021).
- Mentored students (high school through graduate school) and post-docs.

NEXT STEPS:

- Continue Science Investigations:
  - Several papers in prep will be submitted soon; plans to attend meetings, including AGU.
- Continue Model Development To:
  - Improve aerosol implementation and flexibility.
  - Implement and test physics to move model top to the upper atmosphere.
  - Implement and test Early Mars physics.
  - Test nesting/stretching grid configurations for mesoscale modeling.
- Release NOAA/GFDL Cubed-Sphere Mars GCM:
  - Process has started but won't finish until near the end of FY 22.
- Continue to Support Current and Future NASA Missions
- Actively Engage the Community:
  - Legacy Mars GCM (Virtual) Tutorial will be held November 2-4, 2021

Origins of Planetary Systems & Exoplanet atmospheres

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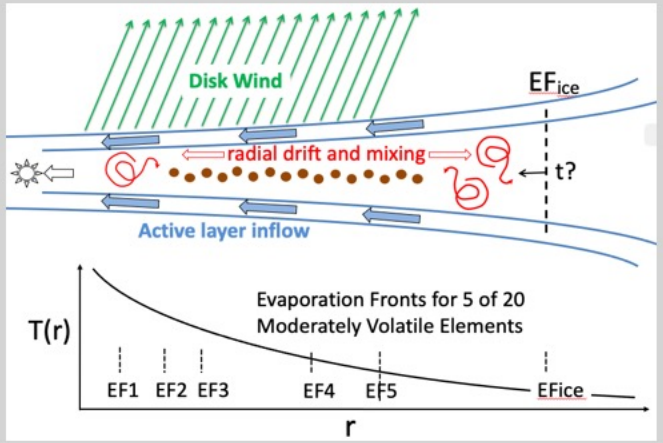
This ISFM targets major questions about the origin and evolution of planetary systems and exoplanets, maintaining close ties with meteoritics and the JSC ISFM, and focusing on:

1) "The First Million Years" of the nebula, and the first planetesimals that formed there (asteroidal and cometary)
2) Turbulence and fluid dynamics in protoplanetary disks
3) Dynamical evolution of exoplanetary systems
4) Radiative transfer modeling of exoplanetary atmospheres
5) Close collaboration with the JSC cosmochemistry ISFM (including on the highlight at right)

Depletion of Moderately Volatile Elements (MVEs) in chondrites, as caused by *open system processes* in a hot early inner nebula

Outburst-related processes in the "First Million Years" of the solar nebula may have caused the ubiquitous, unexplained volatility-dependent depletion of elements less volatile than silicates, and *also* what has been interpreted as enriched refractory elements in carbonaceous chondrites.



Progress FY 21

1. Depletion of moderately volatile elements in chondrites
2. "Pade" 3D CFD code progress/documentation
3. More problems for streaming instability in turbulent nebulae
4. Stability of multiple and trojan exoplanet systems investigated
5. New exoplanet cloud structure model developed
6. Studied cloud structure effect on retrievals of abundances from reflected light data
7. Studied variable irradiation on eccentric giant planets

If this ISFM were to be funded, we would be working on :

1. First ever 3D nebula simulations of turbulent concentration of particles, clump survival, and the planetesimal IMF
2. Extension of MVE depletion studies in the first Myr to include isotopes (with JSC) carbon, water, rapid expansion, disk truncation, radial mixing, and infall
3. Release of the Pade' 3D CFD code to the community
4. AI/ML code for planetesimal formation, intended for release to community
5. Global redistribution of supervolatiles relative to outer planet satellites
6. Dynamical stability of conjoined bodies such as Arrokoth
7. Orbital stability of closely spaced exoplanetary systems
8. Planning and leading focused workshops on the 1st Million yrs

The NASA Ames Laboratory Astrophysics Work Package (LADWP)

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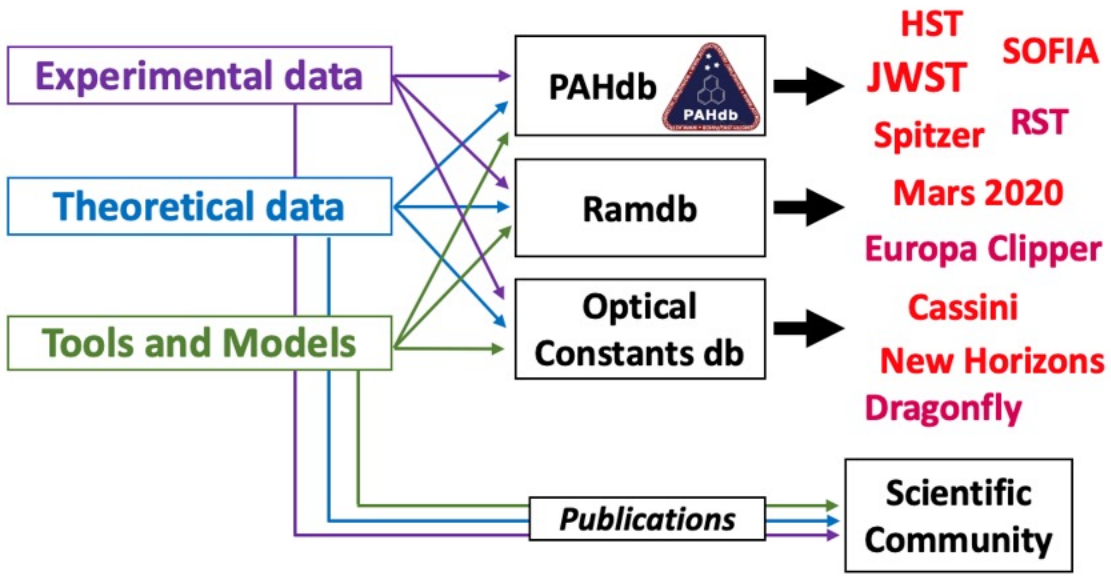
ISFM purpose and objectives:

- **Provide spectral data (experiment + theory) and data analysis tools** to interpret observations, maximizing the science return from many NASA missions
- **Benefit both Astrophysics and Planetary Applications**
- **Coordinate synergistic inter-laboratory research efforts** leveraging Ames' unique expertise (lab+theory+observation)
- **Expand the content and impact of PAHdb (**NASA Ames Polycyclic Aromatic Hydrocarbon Infrared (IR) spectral database)
- **Develop sister databases (**Raman, Optical Constants)



This year's accomplishments are summarized in the lower left quadrant

FY2021 accomplishments + highlights:

- **PAHdb expansion**: → **85 lab spectra** (70 PAH clusters+15 PAHs)
  → **1,030 theoretical spectra** (1,030 PAH clusters)
  → **software analysis tools** and **dedicated online repository**
- **Sister databases created**: → Raman database (**Ramdb**) nearly finished, → Optical Constants database (**OCdb**) structure defined
- **Lab expansion and upgrade**: new operating plan+last IR CRDS parts (**COSmIC**), new IR detector + vacuum pumps (**ICEE**), UV lamp part (**MIOCI**)
- **Data analysis** (theory + experiments) and interpretation of observational data using PAHdb resulted in the publication of **9 papers,** and in **13 presentations** at **11 conferences** (virtual)
- **1 white papers, 8 review panels**

Next steps:

- **Laboratory milestones** will be **completed** (they have been on hold due to labs closing during the COVID-19 pandemic)
→ IR spectra of gaseous PAHs, PAH Raman spectra, optical constants..
- **Theory libraries** will be **completed**
- **Tools** will be **released** for quick JWST PAH data analyses
- **PAHdb** will allow the scientific community to **interpret astrophysical and planetary IR spectra**

Important for JWST

→ *Team involved in ERS + Cycle 1, awarded Cycle 1 observing time*

- **Ramdb** will be **online** early FY2022
- **OCdb infrastructure** will be **completed**

support wide range of NASA missions

Evolutionary Processes that Drove the Emergence and Early Distribution of Life (EPDEL)

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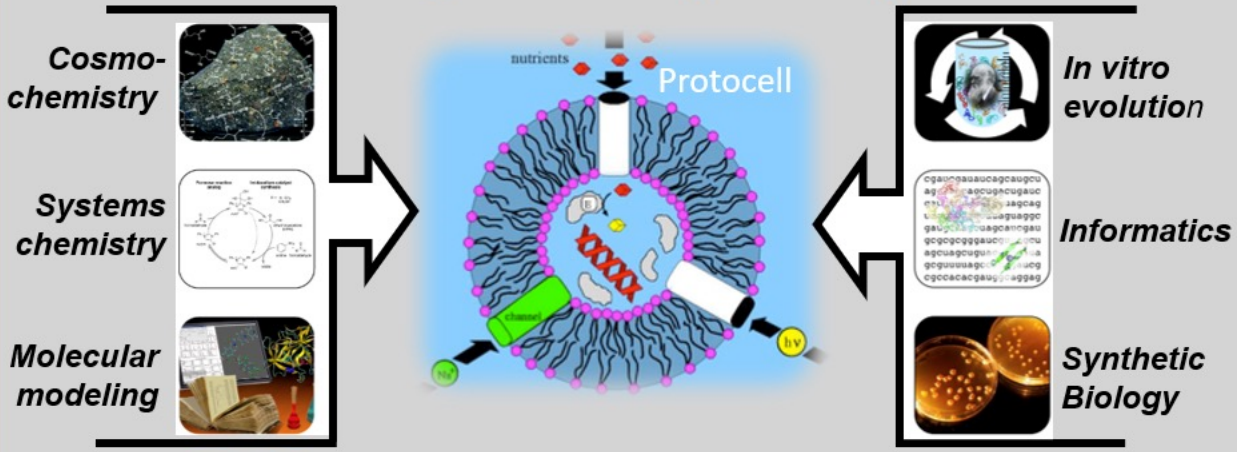
AMES RESEARCH CENTER

Objectives:

- **Establish plausible continuous paths from abiotic processes to the emergence of life.** What cosmo-chemical and planetary processes are likely to provide a path from a habitable environment to an inhabited environment?
- **Understanding the emergence of life as an integrated process.** How can evolution through natural selection endow simple protocells with the ability to support metabolism, information transfer, and energy transduction?

EPDEL integrates multiple disciplines to...



...understand emerging life as an integrated system.

Accomplishments:

- Advances in computational biophysics, molecular evolution, and organic chemistry through both simulations and the analysis of prior experimental work.
  - 9 publications
  - 6 technical talks
- Service to NASA review panels (9, including external reviews) and to relevant non-NASA review panels (4).
- Additional community service, e.g., Build-A-Cell, AstroCheminar, Festival of Science.

Next steps:

- **Bring laboratory experimental spaces and instruments back online.** We have been in mandatory telework status for 18 months.
- **Resume laboratory experiments.**
- **Round two tasks for FY22-FY24:** i) From abiotic formation of amphiphiles to protocellular function; ii) pyruvate reaction networks and the origin of metabolism; iii) evolution of functional peptides and protocell adaptation.

Microbial Innovation and Ecosystems Research (MEIR)

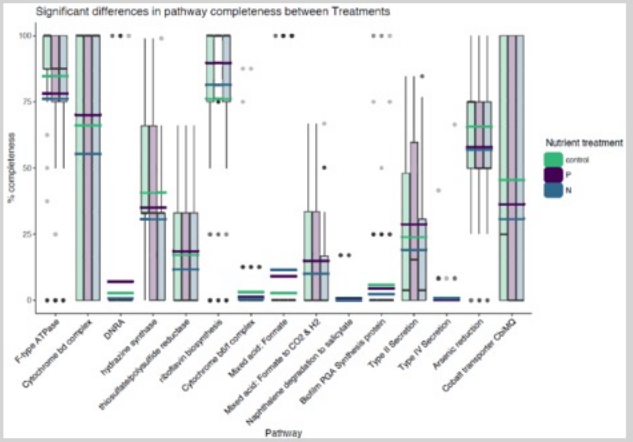
SILICON VALLEY
AMES RESEARCH CENTER

Purpose and Objectives:

A coordinated study of the evolutionary record, biological interactions, and biogeochemical activities of extant life on Earth to inform understanding of the mechanism, history, formation and distribution of biosignatures. Four tasks:

1) The Microbial Ecology of Intact Photosynthetic Ecosystems
2) Sedimentary Systems Research
3) Diversity and Evolutionary Innovation
4) Community Partnerships including AHED

Community functions shift under nutrient manipulations.



Pathway analysis for MAGs from microbial mats incubated under different nutrient conditions

Accomplishment summary:

Task 1 milestone – Metagenome assembled genomes (MAGs) for nutrient experiments complete – pathway analysis underway.

Task 3 milestone – Genomics analysis pipeline is revealing gene-by-gene evolution into new habitats.

Supported activities:
- 2 symposia presentations
- 5 NASA and 1 external review panels
- 9 publications (including 5 white papers)
- 3 proposals not written

Next steps:

MIER will not be continuing past FY21.

Computational research supported for tasks 1 and 3 will wind down, with publications pending.

COVID-19 NPP extension support will allow for continued research on task 1.

Habitable Environments and Biosignatures (HEB)

NASA SILICON VALLEY
AMES RESEARCH CENTER

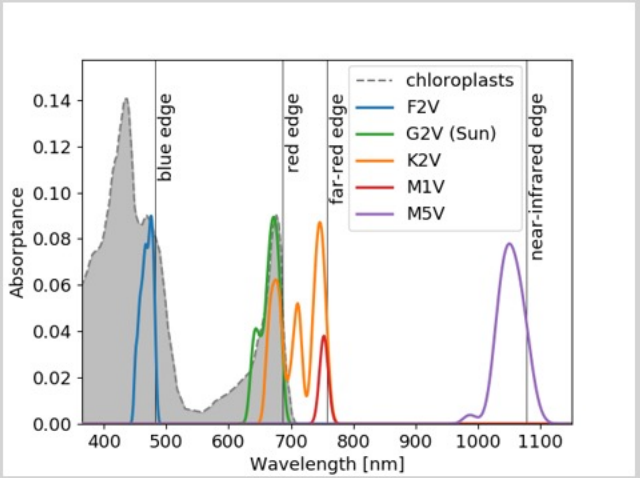
Purpose and objectives:

Developing a science of biosignature detectability

Develop an intellectual framework in which existing spacecraft observations, informed by an understanding of terrestrial biology in its environmental context, can aid in prioritizing science, technology development, and mission implementation for the life detection endeavor:

- Tailoring to (prioritizing among) diverse targets for life detection
- Target instrument capabilities
- Payload options (for life detection *and context*)
- Instrument development and basic research
- Precursor spacecraft observations

The color of plants around other stars from spectral optimization



Lehmer, O.R., Catling, D.C., Parenteau, M.N., Kiang, N.Y., Hoehler, T.M., 2021. The peak absorbance wavelength of photosynthetic pigments around other stars from spectral optimization. Front. Astron. Space Sci. 8.

Accomplishments and top highlights:

- Peer-reviewed papers and book chapters: 13
- White papers: 1
- Conference presentations/invited talks: 2
- Panel Service: 11
- Collaborations w/ other Centers: Goddard Center for Astrobiology
- Extensive involvement in Standards of Evidence for Life Detection Workshop and white paper
- Facilitators for Scialog, Search for Life in the Universe

Next steps:

- PY22-24 Renewal combine CLD and HEB
- HEB Task 1: Develop a framework that constrains detectability as a function of spacecraft and/or telescope observables, with applications to Mars, ocean worlds, and exoplanets.
  - *Subtask 1.1. Biological potential (Leads: Davila, Hoehler)*
  - *Subtask 1.2. Biosignature potential (Leads: Des Marais, Parenteau)*
  - *Subtask 1.3. Biosignature Potential and Diagenesis as Constrained by Mission Data (Lead: Bristow)*
- *Subtask 1.1.* New Biological and Physical Sciences Division (BPSD) and Planetary Science Division (PSD) collaboration

Center for Life Detection (CLD)

NASA SILICON VALLEY
AMES RESEARCH CENTER

Purpose: to support the planning and implementation of missions that will seek evidence of life beyond Earth

Objectives:

- Develop tools that organize astrobiology knowledge in a way that facilitates its use in mission planning
- Identify key research and technology development needs to advance LD mission readiness

The "Life Detection Knowledge Base" Webtool

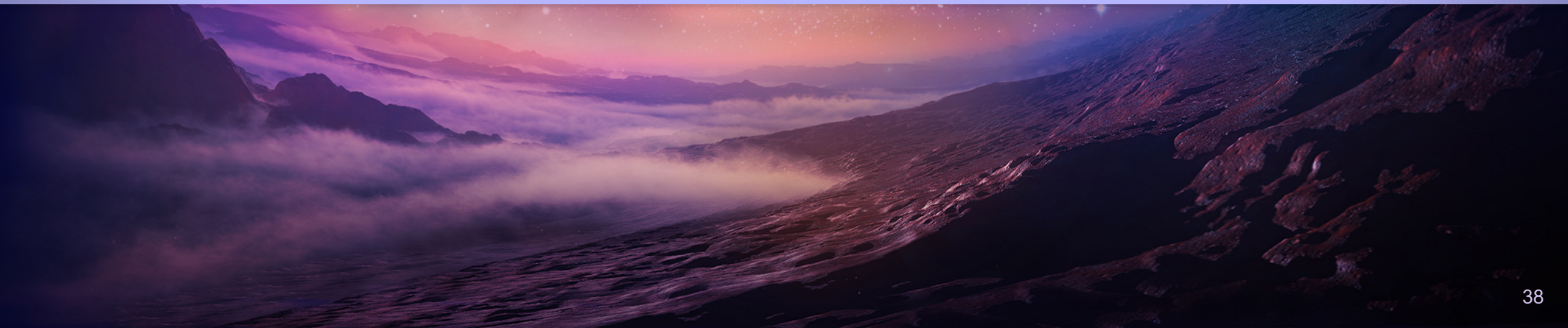
Accomplishments

- "Life Detection Knowledge Base" webtool online
- LDKB workshops (3) & content development groups (5)
- Inception-to-Write-Up involvement in "Standards of Evidence for Life Detection Community Workshop"
- 9 papers, 12 presentations, 16 panel service

Next steps: LKDB Content and Functionality

- Expand LDKB content
- Measurement technology module
- Science traceability module
- Risk assessment module

GSFC



EIMM

O.J. Tucker and Menelaos Sarantos

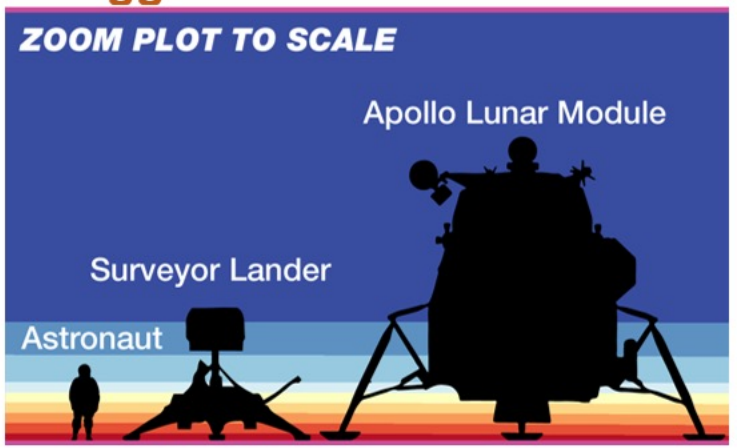
For more information about ISFM at Goddard: https://ssed.gsfc.nasa.gov/MajorRandAThemes/index.html

Summary

- EIMM Studies Comparative Processes linking planetary atmospheres and surfaces to their plasma and meteoroid environments
- 3 topical focus groups: EIMM/1 Exospheres and Atmospheric Escape, EIMM/2 Meteoroids, EIMM3: Plasma Processs and Magnesophere

Nugget

EIMM Researcher **R. Lolachi** is developing tools to understand how dust properties affect sunlight scattering in the lunar exosphere



Accomplishments

FY21 Metrics: Exospheres Ionospheres Magnetospheres Modeling Package			
Pubs	Panel Service	Leadership Positions	Mentorship
13+ Pubs 30+ conf. pres.	11+ panels with 6 as panel chair	President IAU Commission (2018 - 2021): Several contributors to Surface Bounded Exospheres Book	Mentorship of over 10 undergrads, grads and postdocs

Janches, D., J. S. Bruzzone, P. Pokorný, J. D. Carrillo-Sanchez, and M. Sarantos. 2020. **A Comparative Modeling Study of the Seasonal, Temporal, and Spatial Distribution of Meteoroids in the Upper Atmospheres of Venus, Earth, and Mars**. The Planetary Science Journal 1 (3): 59 [10.3847/psj/abba35]

Next Steps

- Welcome New EIMM Co-Lead Diego Janches!
- Continue mini-proposal process building continuity between focus areas and ensuring early career scientists are involved in EIMM with routine tag ups
- Maintain emphasis on community service (e.g., mentorship, panel service and making EIMM software tools available Hosting mini-workshops for each EIMM topical focus area with the broader community

Fundamental Lab Research (FLaRe)

Jamie Elsila and Jen Stern

For more information about ISFM at Goddard: https://ssed.gsfc.nasa.gov/MajorRandAThemes/index.html

Summary

In FY21, FLaRe supported ~60 scientists working on 42 planetary science research projects in a variety of areas including extraterrestrial sample analysis, creation and analysis of planetary and primitive analogs, laboratory and observational spectroscopy, and chemistry of solar system environments.

Accomplishments

FY21 Metrics: FLaRe				
Pubs	Presentations	Outreach	Panel Service	Mentorship
27 published 8 submitted	9 invited talks 20 contributed 7 posters	>20 seminars >10 public events	9 group chiefs 22 panelists >25 externals	3 students 9 postdocs 9 Science PIs

- 2 decadal survey panelists
- 1 SBAG steering committee member; 2 ExMAG members
- Analog materials provided to enable two successful research proposals with external collaborators
- And more …

Nugget

FLaRe-funded analysis of GIFT-collected samples of Icelandic lava, river basalt, and volcanic sediment identified organic molecules associated with formation of secondary minerals. This work suggests multiple formation pathways associated with both biologic and chemical processes in each environment.

Next Steps

- Support lab reopening and recovery, along with mitigation of delays to research efforts caused by Covid-19
- Maintain mini-proposal process to create a balanced portfolio that enables continuity in successful research areas and allows for pilot explorations and responses to new opportunities
- Emphasize service to NASA and to the external community
- Maintain and strengthen inter-ISFM collaborations, within GSFC and across Centers

Goddard Instrument Field Team (GIFT)

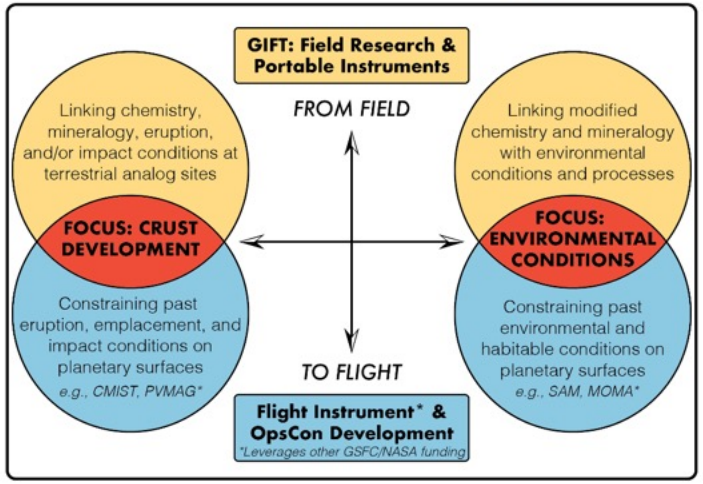
Kelsey Young and Amy McAdam

For more information about ISFM at Goddard: https://ssed.gsfc.nasa.gov/MajorRandAThemes/index.html

Summary

- FY21 Scope of Work:
- VolcanIc Deposit Evolution and Origins (VIDEO): Successful Iceland Campaign Aug 2021
- Field Methods at Analogs of Planetary Sites (FMAPS): Campaign planned to Lava Beds Nat'l Monument delayed to FY22 due to wildfires
- Archiving and Accessibility of GIFT Field Data
- Ames Analog Field Testing, Evaluation and Research (AAFTER): Completed Atacama field data analysis from Sept 2019, delayed Arctic drill test

Nugget



GIFT addresses these research areas through field campaigns to planetary analog sites which explore interdisciplinary science questions and incorporate testing of planetary-relevant instrumentation.

Accomplishments

FY21 Metrics: GIFT		
Publications	Conference presentations	Panel Service
5	29 (e.g., GSA, AGU, LPSC, Lunar Surf. Sci. Wkshp., Terrestrial Analogs Wkshp., NESF/NLS)	2 group chiefs 10 panelists 3 external rev.

- noteworthy papers: Bower et al., 2021; Voigt et al., 2021; Glass et al., 2021
- notable service: LEAG and MEPAG committees, academic degree committees, workshop/conference organizing committees

Next Steps

- Development of Community Safety Resources & Logistics Plans
- **Development of Field Data Management Strategies:** Work on field data archiving and Data Management Plan for field data
- **Partnerships with NASA ARC and JSC and academic institutions:** ARC-funded teams expanded moving into FY22, strong JSC collaboration, students and postdocs funded at multiple academic institutions
- **Development of Early Career Scientists:** Numerous early career scientists funded through GIFT: GIFT enables them to acquire field experience
- **Public Engagement:** Input to Agency-recognized NASA Expeditions social media accounts and NASA's Planetary Analogs website, outreach events

Planetary Geodesy

E. Mazarico and M. Barker

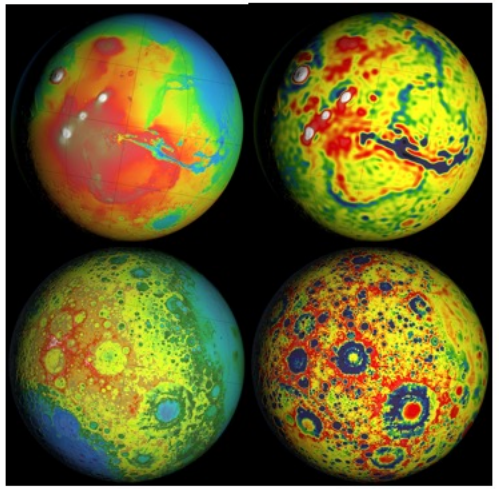
For more information about ISFM at Goddard: https://ssed.gsfc.nasa.gov/MajorRandAThemes/index.html

Summary

- **Gravity & Geodesy** obtain geophysical measurement, develop new methodology;
- **Geophysical Analysis** investigate planetary interiors;
- **Topography** produce foundational products;
- **Illumination & Radiometry** science analysis, exploration support

Nugget

Our 2019 detection of an inner core elicited debate about Mercury's interior structure.
In a follow-up study, we show through rigorous interior structure modeling that our low moment of inertia and higher k_2 values are the *only* consistent set, strengthening our former result.



Accomplishments

FY21 Metrics: Planetary Geodesy					
Pubs	Panel Service	Reviews and Committees	Smp Anlys	Data Access	Tool Access
Pap. 13 Conf. 20	**1 chair 4 panelists 2 external**	**Paper reviews (19); Thesis committees (2); MAPSIT**	**N/A**	**pgda.gsfc.nasa.gov**	**PyXover and py-flux on GitHub**

- Improvements to the INPOP21a ephemerides (lunar orbit and rotation)
- chair of ROSES panel

Next Steps

- Mini-proposal process with continuity in scope with previous successful scientific efforts, such as radio tracking data processing, geophysical analysis, illumination studies, …
- Continue support of early-careers and their integration within the Planetary Geodesy portfolio
- Maintain emphasis on community service, such as with the production of higher-level products from raw geodetic datasets, and their regular release through our data portal

Sellers Exoplanet Environment Collaboration

Ravi Kopparapu, Avi Mandell, Elisa Quintana

Summary – The Five-Year Mission

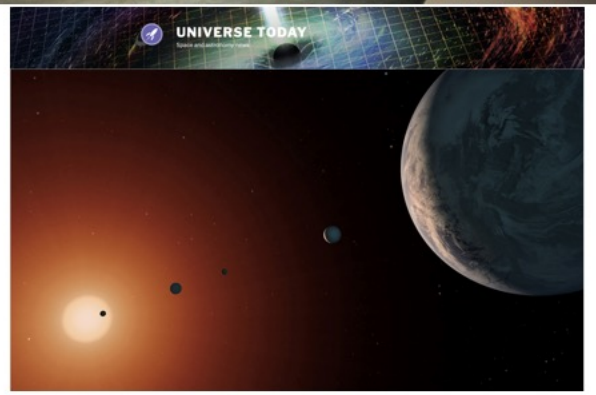
- Advancing the coupling of stellar models with atmospheric heating and chemistry models
- Enhancing our flexible chemistry and climate models with new laboratory and experimental data
- Updating multiple independently developed GCMs to predict robust observables
- Expanding tools for simulating, retrieving and interpreting exoplanet observations.

Accomplishments

FY21 Metrics: [work package]

Pubs	Panel Service	Leadership Positions	Tool Acces
20+	>10 panelists	ExoPAG, NExSS, Conference SOCs	EMAC,PSG,ROCKE3D,ExoCAM

- TRAPPIST Habitable Atmosphere Intercomparison (THAI) workshop report – **Fauchez +**
- Flares, Rotation, and Planets of the AU Mic System from TESS Observations, **Gilbert +**



How To Search the Chemical Makeup of Exoplanet Atmospheres for Hints at Their History

Author's note – this article was written with Dr. Vincent Kofman, a scientist at NASA's Goddard Space Flight Center (GSFC), working in the Sellers Exoplanet Environments Collaboration (SEEC), and the lead author on the research it discusses.

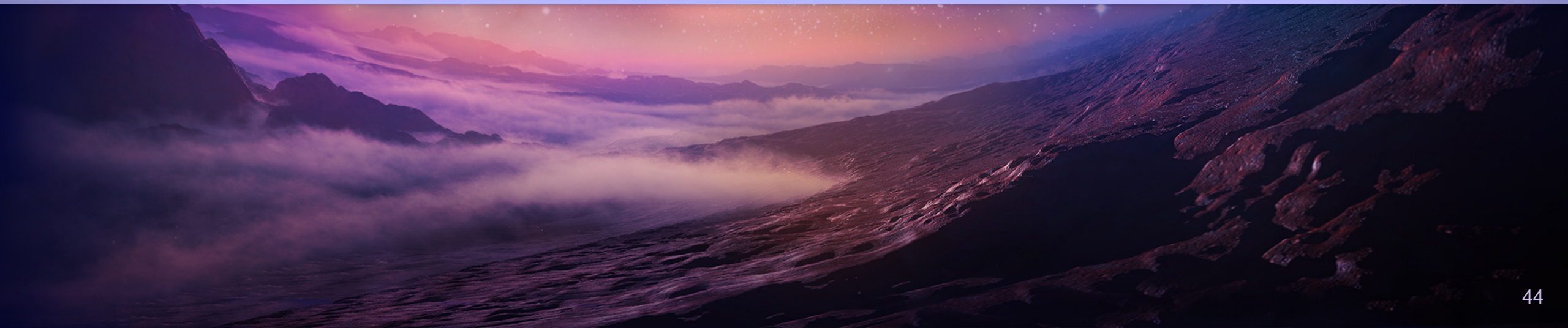
Thousands of exoplanets have been discovered in the recent decades. Planet hunters like TESS and Kepler, as well as numerous ground-based efforts, have pushed the field and we are starting to get a total number of planets that will allow us to perform effective statistical analysis on some of them.

Dr. Vincent Kofman's article in *Universe Today*

Next Steps

- Mini-proposal process once a year. Currently 32 active projects in FY21. 'Retreats' to inspire new cross-divisional project ideas.
- Ensure early-career scientists are integrated with SEEC community by engaging them in workshops, LOC organization etc.
- Maintain emphasis on community service, such as through panel service, workshops, EMAC/PSG access.

JSC



Coordinated Analysis Work Package

Astromaterials Research and Exploration Division
NASA Johnson Space Center
Work Package Lead: Lindsay P. Keller

ISFM Work Package Summary

Research tasks in the Coordinated Analysis Work Package focus on coordinated microstructural, chemical, mineralogical, and isotopic microanalyses of presolar and early solar system solids, the building blocks of the planets, and their subsequent evolution by aqueous, thermal, and regolith processes on their parent bodies. Analyses are performed in a carefully coordinated sequence on the same sample in order to maximize the science return from precious materials.

Overall Accomplishments

# of Peer Reviewed Publications: 33 Selected Papers:

[1] Zolensky M et al. (2021) The nature of the CM parent asteroid regolith based on cosmic ray exposure ages. *MAPS* 56, 49-55. [2] Laczniak, D. L. et al. (2021) Characterizing the spectral, microstructural, and chemical effects of solar wind irradiation on the Murchison carbonaceous chondrite through coordinated analyses. *Icarus* 364, in press. [3] Keller, L. P. et al. (2021) Solar energetic particle tracks in lunar samples: A transmission electron microscope calibration and implications for lunar space weathering. *MAPS*, 56, in press. [4] Han et al. (2021) Atomic-scale structure and non-stoichiometry of meteoritic hibonite: A transmission electron microscope study. *American Mineralogist*, in press.

# of Conference Abstracts: 43. Selected Abstracts:

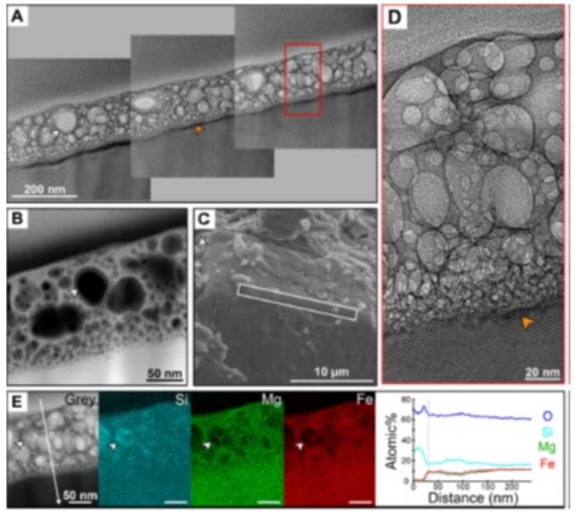
[1] Nguyen et al. (2021) Bulk oxygen isotopic compositions of anhydrous interplanetary dust particles: Indication of an 16O-poor reservoir in the outer Solar System. MAPS. [2] Erickson et al. (2021) Deciphering extreme mineral records; microstructural phase heritage of shocked materials. M&M.

# of NASA Peer Review Panels: 10 (1 group chief, 6 panelists).

Graduate student committees/supervised: 11

Science Nugget

Preparing for the return of Bennu and Ryugu samples through 1) mineralogical, petrological, and isotopic studies of recent CI/CM meteorite falls, 2) space weathering experiments on Murchison to quantify solar wind and impact processes and their effect on remote sensing datasets and 3) using solar flare track densities to constrain surface exposure ages of space weathered grains at 1 AU and their application for returned asteroid samples.



He+ irradiated Murchison (Laczniak et al. 2021)

Future Work

[1] Coordinated mineralogy/petrography/isotopic analyses of presolar grains in meteorites and IDPs and in putative Kuiper belt IDPs, and condensates in refractory inclusions. [2] Search for and characterization of aqueous fluid inclusions in primitive chondrites to understand the origin of parent body fluids. [3] Determine the functional chemistry, molecular structure and isotopic compositions of organic nanoglobules in primitive meteorites.

[4] Space weathering experiments on analogs including hypervelocity impacts and low flux irradiation experiments on carbonaceous chondrites.

[5] Coordinated analyses involving electron backscatter diffraction microstructural characterization and SIMS U-Pb dating to determine the age of shock resetting of lunar zircon grains. [6] Facility upgrades: Install and test new SEM, new SDD on old SEM, procurement of Hyperion ion source for the NanoSIMS and the cathodoluminescence spectrometer for the new SEM.

ASTROMATERIALS RESEARCH AND EXPLORATION SCIENCE
JOHNSON SPACE CENTER

Geochemistry and Cosmochemistry Work Package

Astromaterials Research and Exploration Division
NASA Johnson Space Center
Work Package Lead: Justin Simon

ISFM Work Package Summary

Research tasks in the GCWP utilize specialized laboratories and analytical instruments to study the early solar system and origin and evolution of rocky planets. These fundamental measurements complement planetary mission data and astronomical observations of other solar systems and help define the scientific framework for NASA Space Science Missions. The work primarily focuses on compositional measurements of returned samples and meteorites from asteroids, the Moon, and Mars.

Overall Accomplishments

# of Peer Reviewed Publications: n=26 (16 co-authored with other JSC ISFM WP) Selected Papers: [1] Mittlefehldt et al. (accepted) Eucrite-type Achondrites: Petrology and Oxygen Isotope Compositions, *MAPS*, [2] Antonelli and Simon (2020) Calcium isotopes in high-temperature terrestrial processes, *Chemical Geology*, [3] Yeung and Hayles (2021) Climbing to the Top of Mount Fuji: Uniting Theory and Observations of Triple Oxygen Isotope Systematics, Reviews in Mineralogy and Geochemistry, [4] Brounce et al. (2020) Sulfur in the Apollo lunar basalts and implications for future sample-return missions, *Elements*

# of Conference Abstracts: n=16

Selected abstracts: [1] Deligny et al. (2021) First in-situ nitrogen isotope measurements in Martian meteorites, Goldschmidt

[2] Pourkhorsandi et al. (2021) Probing the cerium stable isotopic dynamics of terrestrial and extraterrestrial rocks. Goldschmidt

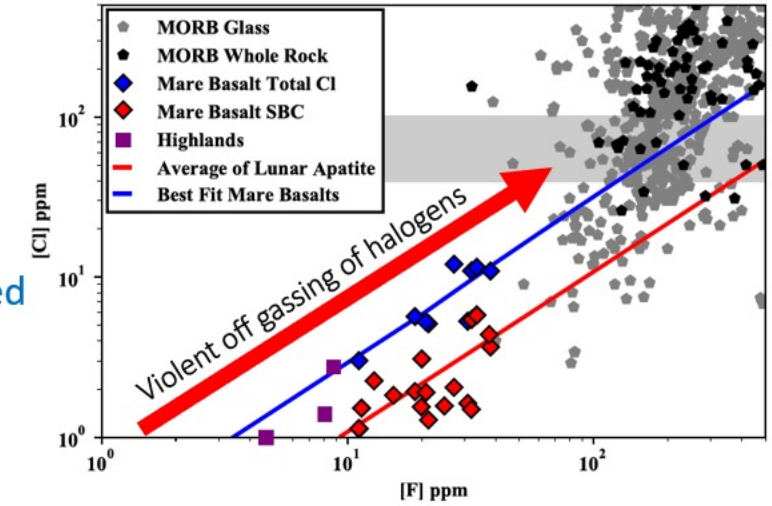
# of NASA Peer Review Panels Served on: 4 panelists incl. 1 Group Chief, 3 appeals, 1 commitment to serve as panelist for future rolling reviews

Other Service Activities of Note: Member of Planetary Science and Astrobiology Decadal Survey, 2023-2032, Chair of the Research and Assessment Team, Women+ of Color Project at Harvard University, JSC NPP Fellowship Coordinator

Science Nugget

Anthony Gargano (student), Zachary Sharp, Charles Shearer, Justin Simon, Alex Halliday, and Wayne Buckley (2020) Chlorine isotope compositions and halogen contents of Apollo return samples, *Proceedings to the National Academy of Sciences*

Lunar materials are depleted in fluorine and chlorine 10x relative to Earth (halogens measured by ICP-MS at NASA JSC)



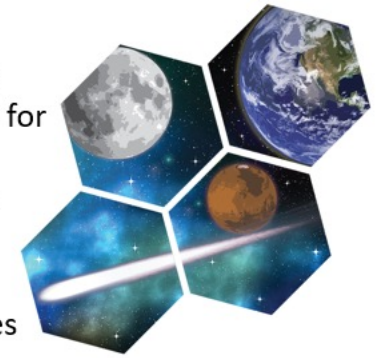
Future Work

P1. Isotopic, chemical, and textural studies of chondrite components to test astrophysical models

P2. Track moderately volatile element isotope compositions and trace element abundances in chondrites to test models for early nebula processes (disk winds, ongoing infall, primary accretion, mixing, and radial condensation and evaporation fronts)

P3. Determine the distribution and evolution of volatile elements in planetary bodies in the Solar System (meteorites and Apollo samples)

P4. Study the geochemistry and timing of planet differentiation leading to ancient crusts on asteroids, the Moon, and Mars



ASTROMATERIALS RESEARCH AND EXPLORATION SCIENCE
JOHNSON SPACE CENTER

Work Package Lead:
Liz Rampe, JSC XI3

Mission-Enabling Research Work Package

Astromaterials Science and Exploration Division, NASA Johnson Space Center

ISFM Work Package Summary

Research tasks in the Mission-Enabling Research Work Package focus on experiments, measurements, and analog research to interpret data returned from planetary missions and characterize geological processes on planetary bodies. The research in this work package helps identify habitable environments on Mars by constraining environmental conditions, like pH, temperature, and redox, from compositional measurements of the martian surface. Furthermore, efforts to synthesize martian and lunar analog materials feed into human exploration goals by providing the scientific and engineering community with geologic materials to prepare for human missions to the Moon and Mars.

Overall Accomplishments

26 Peer Reviewed Publications (12 from analog work, 14 from analog+mission work – i.e., incorporating mission datasets)

Selected papers:

Peretyazhko, T. S., **D. W. Ming**, **R. V. Morris**, D. G. Agresti, and **W. P. Buckley**. 2021. Formation of Fe(III) (hydr)oxides from Fe(II) sulfides: implications to akaganeite detection on Mars. ACS Earth Space Chem, https://doi.org/10.1021/acsearthspacechem.1c00075.

Clark, J. V., **P. D. Archer**, J. E. Gruener, **D. W. Ming**, **V. M. Tu**, **P. B. Niles**, and S. A. Mertzman. 2020. JSC-Rocknest: A large-scale Mojave Mars Simulant (MMSL based soil simulant for in-situ resource unilization water-extraction studies. Icarus, Vol. 351, doi.org/10.1016/j.icarus.2020.113936.

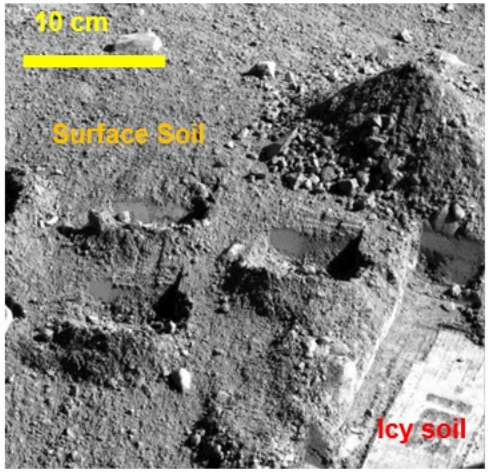
Morris, R. V., & 28 co-authors, including **E. B. Rampe, R. Christoffersen, D. W. Ming, L. Le, V. M. Tu, J. V. Clark, T. G. Graff, M. Thorpe**. 2020. Hydrothermal Precipitation of Sanidine (Adularia) Having Full Al,Si Structural Disorder and Specular Hematite at Maunakea Volcano (Hawai'i) and at Gale Crater (Mars). Journal of Geophysical Research: Planets, Vol. 125, e2019JE006324, https://doi.org/10.1029/2019JE006324.

59 Conference Abstracts (40 from analog work, 19 from analog+mission work)

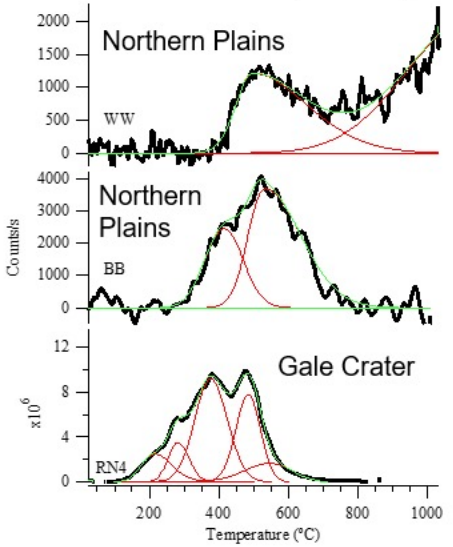
Served on 8 NASA Peer Review panels

Mission-Enabling scientists serve on 8 PhD student committees, mentored 3 undergraduate students, and mentored 14 high school students.
18 public talks to elementary- through undergraduate-level students

Science Nugget: Re-analysis of Mars Phoenix TEGA data indicates organic C, Fe-carbonate, and Ca-carbonate are present in Northern Plains soils (PI: Sutter)



Northern Plains soils studied by Mars Phoenix



Low-T CO_2 releases in Northern Plains and Gale crater are consistent with organic C and Fe-carbonate. High-T CO2 releases in Northern plains are consistent with Ca-carbonate.

Next Steps

- Mars-analog fieldwork in Iceland in summer 2022 with the GIFT WP to study soil organic content and preservation
- Building M2020 SHERLOC UV Raman spectral database with Mars-analog samples
- SAM-like EGA of nitrates and additional Mn phases (crystalline and amorphous) for comparison to MSL-SAM data
- Characterize the mineralogy and geochemistry of Mars- and Moon-analog samples collected from Iceland, Antarctica, and Hawaii via XRD, XRF, IR spectroscopy, electron microscopy, and ICP-OES
- Synthesize Mars-relevant Fe-oxides/oxyhydroxides from Fe-silicates
- Synthesize trioctahedral smectite from basaltic glass at a range of pH and pCO_2

Organic Geo- and Cosmochemistry Work Package

Astromaterials Research and Exploration Division
NASA Johnson Space Center
Work Package Lead: Aaron Burton

ISFM Work Package Summary

The two research tasks in the Organic Geo- and Cosmochemistry Work Package focus on the analysis of organic matter in rock and regolith samples to determine how organic molecules are formed, how they evolve over time in different geochemical environments, and the effects of interplay between organics and their inorganic host materials. Analyses are performed on molecules directly isolated from extraterrestrial samples, such as meteorites and returned samples, produced by laboratory reactions simulating prebiotic chemistry, and *in situ* analyses of molecules in astromaterials samples.

Overall Accomplishments

# of Peer Reviewed Publications: 1 published + 2 in review + 2 in preparation

Selected Papers:

- Aponte et al. (2020) *Meteoritics & Planetary Science* 55, 2422 – 2439.
- Thomas-Keprta et al. (in press) *Geochimica et Cosmochimica Acta*
- Kaiser et al. (in review) *Meteoritics & Planetary Science*

# of Conference Abstracts: 10

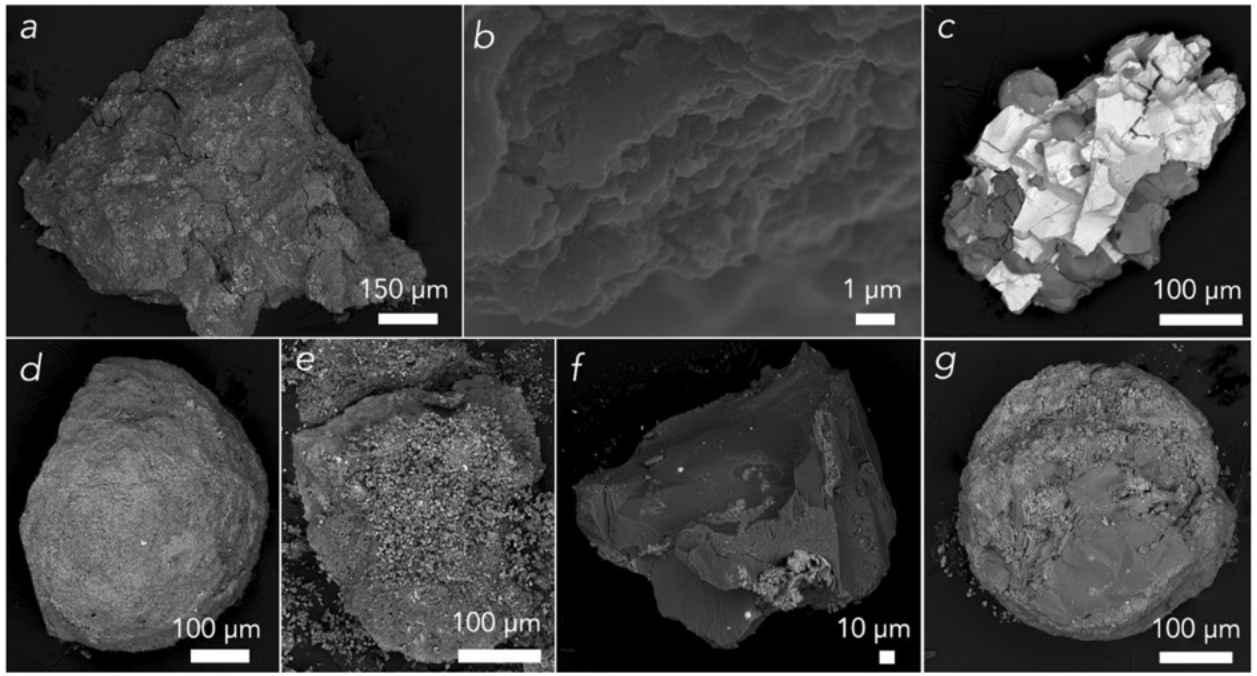
# of NASA Peer Review Panels: 5

Other Service Activities of Note:

- 1 detailee to HQ for 0.75 FTE
- 1 guest-editorship of *Symmetry* journal special issue
- Assistance to COSPAR working group on Mars returned sample safety
- Panelists on 2 EPO events
- Mentoring Ph. D. student
- MSI fellowship sponsor/mentor for 2 students

Science Nugget

Mineral separates from LON 94101 were hot-water extracted individually for amino acids, after which the solid residues were transferred to SEM mounts for analysis. Below are several BSE images of grains for which amino acid contents were determined individually, and for which correlations between mineralogy and organic composition will be investigated.



Future Work

- Future *ex situ* work will entail analysis of a range of aqueously altered carbonaceous chondrites to determine if aqueous alteration has discernable effects on the distribution of organics amongst mineral phases.
- For *in situ* studies, analyses have focused primarily on CR, CM, CV and CO chondrites; this work will be expanded to investigate mineral/organic associations in CB, CK and relatively primitive ordinary chondrites.

ASTROMATERIALS RESEARCH AND EXPLORATION SCIENCE
JOHNSON SPACE CENTER

Planetary Process Simulation Work Package

Astromaterials Research and Exploration Division
NASA Johnson Space Center
Work Package Lead: Kevin Righter

ISFM Work Package Summary

Carry out petrologic simulations of planetary interiors and surfaces (experimental petrology lab), and hypervelocity impact to understand formation conditions of astromaterials (rocks, shock history, geologic relations) (experimental impact lab)

Overall Accomplishments (FY21)

# of Peer Reviewed Publications: 13 published + 5 in review + 2 in preparation

Selected Papers:

-**McCubbin** et al. (In Press) The abundances of F, Cl, and H_2O in eucrites: Implications for the origin of volatile depletion in the asteroid 4 Vesta. *Geochimica et Cosmochimica Acta*.

-Hörz F., **Cintala M.J.** and Christiansen E.L. (2021) Low-density sabot stripper: A feasibility study. International Journal of Impact Engineering 153, p.103859.

-**Righter** et al. (2020) Activity coefficients of siderophile elements in Fe-Si liquids at high pressure. Geochem. Persp. Lett. 15, 1-6.

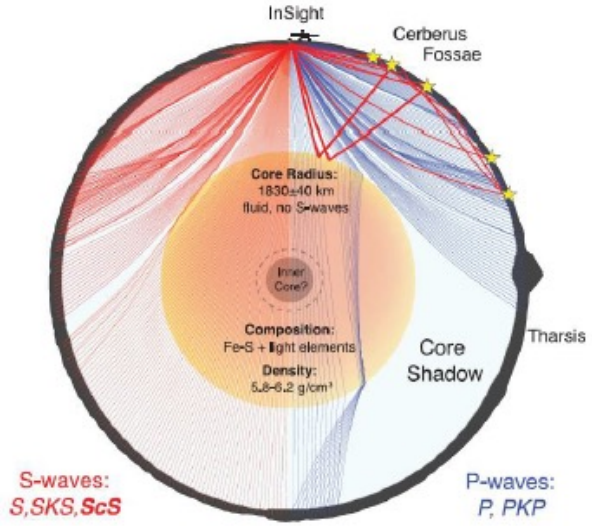
-**Righter** et al. (2020) Ag isotopic and chalcophile element evolution of the terrestrial and martian mantles during accretion: New constraints from Bi and Ag metal-silicate partitioning. Earth and Planetary Science Letters, 552, 116590.

-**Righter** et al. (2020) Mantle-melt partitioning of the highly siderophile elements: new results and application to Mars. Met. Planet. Sci 55, 2741-2757.

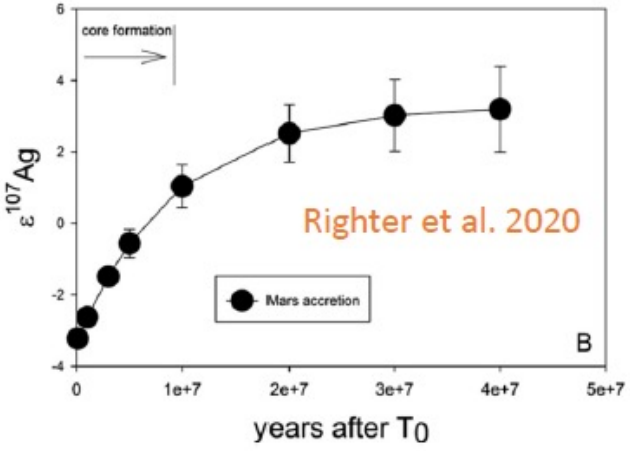
# of Conference Abstracts: 15 **# of NASA Peer Review Panels:** 4

Other Service Activities of Note: 3 associate editors, 28 journal reviews, 24 outreach events, 8 society or community panels.

Science Nugget: InSight Mars core size and composition (10-15% S) imply Ag isotopic anomalies in mantle.



Stähler et al. 2021



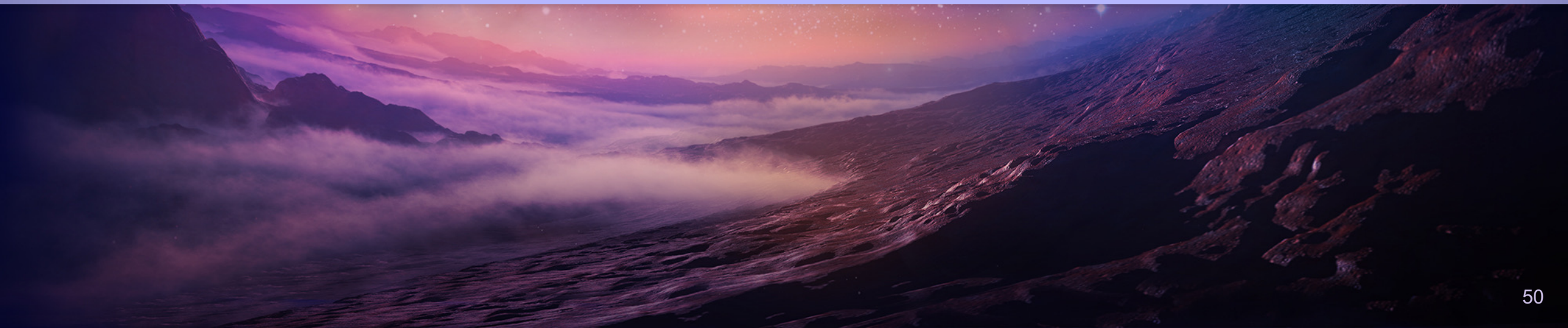
^{107}Pd to ^{107}Ag ($t_{1/2} = 6.5 \times 10^6$ years)

Future Work - Labs re-opened and poised to carry out experimentation proposed in ISFM cycle 2; Inter-WP (GCWP, CAWP) and inter-center (GSFC) collaborations

Project 1: Characterizing the strength-to-gravity transition in impact cratering
Project 2: Disruption of ordinary chondrites
Project 3: The effects of target-container size on impact experiments
Project 4: Isotopic tracers and volatile abundance in apatite
Project 5: low FeO planetary surfaces
Project 6: Metal-silicate partitioning of siderophile elements
Project 7: Spinel as a sensor of redox conditions

Applications to Mercury, Venus, Earth, Mars, Moon, asteroids

MSFC



Marshall Interdisciplinary Planetary Scientists (MIPS)

Marshall Space Flight Center ISFM Lead: Dr. Michael Zanetti (ST13)
Organization: MSFC Heliophysics & Planetary Science Branch/ST13,
Dr. David McKenzie, manager
michael.r.zanetti@nasa.gov
david.e.mckenzie@nasa.gov

MSFC's planetary scientists conduct impactful research while also providing meaningful scientific and exploration context for our engineering organizations. ISFM support will allow our scientists to excel at their scientific areas of interest and provide continued service to NASA missions and panels, the scientific community, and public engagement.

MIPS Team members:

Michael Zanetti, ISFM lead (Research areas 1.1, 1.2) *
Heidi Haviland (Research area 1.1) *
Paul Bremner (Research area 1.1) *
Caleb Fassett (Research area 1.1)
Dennis Gallagher (Research area 1.3)
Alvin Cantrell (Research area 1.3)
Eric Bradley (Research area 1.3)

* Early Career scientist

Technical Objectives:

The Marshall Interdisciplinary Planetary Science (MIPS) program will support 3 primary areas of research:

1.1 Remote-Sensing and Mission Data Analysis. Interdisciplinary projects combining electromagnetic sounding of space plasma environments, modeling of thermal evolution of the Moon and other rocky planet interiors, and CLPS science data; to support lunar surface processes investigations and Cross-Artemis Site Selection Analysis (CASSA) and Artemis and HLS lunar surface requirements.
1.2 Comparative Planetology using Mobile LiDAR. Focused around the Kinematic Navigation and Cartography Knapsack (KNaCK), a unique, mobile, velocity-sensing light detection and ranging (LiDAR) instrument being developed in our group.
1.3 Dusty Plasma Laboratory (DPL). The DPL is used to determine the electrostatic charging, optical, and gas accretion properties of dust and icy dust as a function of size, material, and environmental conditions.

Relationship of ISFM to Service:

The MIPS ISFM projects enable the Agency's exploration initiatives, with focused scientific research about the Moon, Mars, and beyond, and address SMD 2020-2024 Strategies, NASA Decadal Science goals, and Artemis Science Goals. MIPS team members participate in:

- Artemis Science Definition Team
- Cross-Artemis Site Selection and Analysis (CASSA) Technical Assessment Teams
- NASA Decadal Survey
- Precision Landing and Hazard Avoidance for Human Landing System (HLS) and Space Launch System (SLS) programs
- Design Specification for Natural Environments (DSNE) lunar surface, exosphere, and plasma environment sections
- Review panels, journal manuscript reviews, society committees
- Engagement of the public through colloquia and classroom visits